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CONGENITAL UMBILICAL HERNIA

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ALTHOUGH actually a rare finding, congenital umbilical hernia is one of the most frequent malformations of the ventral abdominal wall. Strictly, it is not a true hernia at all, because the viscera contained in the sac have never been in the abdominal cavity, but have remained outside in their primitive position in the celomic cavity where they budded in the first weeks of embryonal life. The condition is, therefore, more properly an eventration, but because, from a surgical viewpoint, it has all the characteristics of a hernia, the term congenital umbilical hernia has persisted.

HISTORY AND LITERATURE

Umbilical hernia has been recognized from the days of Celsus, but there is no record that this author knew such a hernia might be congenital. He discusses the condition in children 7 to 14 years of age, and describes an operation consisting of reduction of the hernia and ligature of the sac. However, he does not advocate this procedure for infants. The same is true of Paulus, who followed Celsus in his ideas regarding treatment. Franco's treatise on hernia, published in the sixteenth century, does not deal with the umbilical type.

Although Ambroise Paré described congenital umbilical hernia as early as 1634, very few cases of this condition are reported in the literature before the nineteenth century. In fact, Aribat in a review of the older literature on this subject, in 1901, lists only 9 cases published prior to 1800. The earliest of these was seen by Scultetus in 1643, but here no treatment was attempted.

Later in the seventeenth century, the French obstetrician Mauriceau reported 3 cases. In 1 the child was stillborn and exhibited other deformities. In the 2 other instances the child was born alive, but died within a few days, without treatment. Two important treatises on hernia published in the latter part of the eighteenth century by Pott and Richter, respectively, describe umbilical hernia and note that it occurs frequently in infants, but neither authority recognizes the condition as congenital. Richter advises the use of bandages in the treatment of umbilical hernia in children; and Pott states: "In young subjects and small herniæ, a bandage worn at the proper time generally proves a perfect cure." While the latter authority advises early operation in the case of inguinal and scrotal hernia, he states that he cannot "press it so much" in umbilical hernia, but would "make it the last remedy," as "the success of it is very rare."

Early in the nineteenth century, however, the occurrence of umbilical hernia as a congenital condition had become generally recog-

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nized, and various methods of treatment of the condition in the newborn were proposed. The British surgeon, William Hey, in his *Practical Observations on Surgery*, published in 1803, describes 3 cases of "hernia congenita umbilicalis," the first of which was seen in 1772.

Sir Astley Cooper in his treatise on crural and umbilical hernia (1807) notes that children are sometimes born with an umbilical hernia. He cites a case, reported to him by James Hamilton, in which the hernia was reduced, the sac ligated at its base and "cautiously" opened. The edges of the abdominal wall were then brought together with two silver pins and some adhesive straps; the sac was allowed to drop off, and cure was said to be complete in a few days. This child did well for 8 months, then died from an acute intestinal disease. Hamilton's report is of interest because it contains the statement that he had previously seen a number of such congenital umbilical hernias, but had not attempted operation because he had "always considered such cases strictly desperate."

In 1809, the Italian surgeon Antonio Scarpa published his treatise on hernia, discussing congenital umbilical hernia as distinct from the acquired form. He mentioned 2 cases observed by him, in 1 of which a lobe of the liver was included in the hernial sac. Scarpa believed that infants with congenital umbilical hernia usually live but a short time, either because they show other congenital malformations or because the hernia is so large that it cannot be reduced. He advised reduction wherever possible followed by the application of a compression bandage.

Very little attention is paid to congenital umbilical hernia in early textbooks on obstetrics. Mauriceau, already mentioned, reported 3 cases. The first American textbook on obstetrics—that of Samuel Bard—makes no mention of the subject in the first edition (1803). In the last (fifth) edition (1819), however, this statement appears: "Some children are born with umbilical and others with inguinal rupture, or these complaints may be discovered soon after. The umbilical rupture admits of an easy cure by being kept in by a strong adhesive plaster and moderate pressure by a proper bandage." Scanzoni (1855) refers to congenital umbilical hernia, and recommends treatment by reduction and compression bandage, or by bandaging alone where the hernia is small.

INCIDENCE

The treatise by Aribat (1901) lists 160 cases of congenital umbilical hernia collected from the literature. Walravens (1902) in a similar treatise presents a collection of 78 cases from the literature between 1881 and 1900, but as about 50 of these cases are among those cited by Aribat, it can safely be said that up to 1900 less than 200 cases of congenital umbilical hernia had been reported in the literature of the whole world. In 1930, a Kiel University thesis written by Altpeter presented a collection of 109 cases reported between 1900 and 1929, to which he added 3 new cases. Since 1929, 24 cases have been reported in the foreign literature, and 22 by American and British authors, 17 of which were published in the United States.

Discussing the general incidence of congenital umbilical hernia, Kleiner (1930) quotes statistics from various obstetrical clinics in Leningrad showing that the incidence in these clinics varied from 1 in 5,203 deliveries to 1 in 11,660. In the Rostow (on the Don) Hospital, he found only 2 cases in 9,500 deliveries. Ludwig refers to these figures and adds similar statistics for the Munich Clinic from 1862 to 1882 (quoted from Lindfors) showing 4 cases in 20,735 deliveries. These two statistical reports taken together indicate an average of one case of congenital umbilical hernia to every 6,600 deliveries, thus roughly corresponding to the estimates given by others.

In 8,410 deliveries at the Touro Infirmary in New Orleans, Hebert notes only 2 cases of congenital umbilical hernia. At the Charity Hospital in the same city no cases had been found in 10,995 deliveries. Smith, reporting 1 case operated on at the Lying-In Hospital, New York City, in 1932, found 7 other cases previously recorded at that hospital among 1,036 cases of congenital anomalies.

Ludwig notes that on the basis of 1 case of congenital umbilical hernia to 6,600 deliveries,

or even to 10,000 deliveries, several thousand of such cases must have occurred in Europe in the last 50 years. A review of the literature, however, shows that only a few more than 100 cases have been reported. It is probable, he concludes, that most of the children with congenital umbilical hernia are stillborn or die soon after birth and the cases are never reported. It is probably true also that many such infants are delivered by midwives and are never seen by a physician, much less by a surgeon. If this is the case in modern times, it was no doubt still more true in the earlier centuries. This explains why umbilical hernia was not recognized as congenital by the earlier writers.

In 5,017 successive deliveries at the Sydenham Hospital, New York City, resulting in 5,079 births, of which 4,910 were living children and 169 were stillborn, only 2 cases of congenital umbilical hernia are recorded. The first is the case I am reporting; the second, while of sufficient size to draw attention, was not so formidable as to require an immediate operation.

In an obstetric practice of 30 years, in the early days of which the author delivered the patients in their own homes and took personal care of the newborn, small umbilical hernias after separation of the cord were not very uncommon, and were invariably cured by strapping with adhesive plaster.

Thus one may fairly assume that, if the cases had been followed up, small herniations at the umbilicus would be found to have occurred much more frequently than the hospital records would indicate. One thing, however, is certain—that of massive hernia only this 1 case has been observed at the Sydenham Hospital, the only other herniation of sufficient size to be noted on the chart not having been extensive enough to demand prompt surgical interference.

REPORT OF CASE

L. C., white, aged 17 years, secundipara, was admitted to the Sydenham Hospital May 3, 1932, in active labor. She gave a history of one previous pregnancy which went to term, when, at the age of 16 years, she was delivered of a normal female child, who is living and well.

Fig. 1, left. Frontal view showing defect in abdominal wall at umbilical area. Hernia of the liver. At the lower pole of the hernial mass may be seen the tied stump of the cord. Taken 4 hours after birth.

Fig. 2. Same as Figure 1. Lateral view.

The patient was delivered spontaneously at term of a living female child, weighing 6 pounds 14 ounces.

Case report of Baby C. The child was born spontaneously at term. A large defect was found in the abdominal wall, through which a dark red, bluish mass protruded (frontispiece). This was covered by a thin, shiny, translucent membrane, at the lower pole of which the cord emerged. This membrane, or hernial sac, continued with the covering of the umbilical cord. The child was otherwise normal (Figs. 1 and 2).

Diagnosis: massive hernia into the umbilical cord. The dark bluish content of the hernia was assumed to be the liver. This assumption was corroborated 12 hours later by operation.

A vertical incision was made through the translucent membrane, i.e., the hernial sac. The entire sac covering the liver was removed down to the edges of the abdominal defect. The skin at the edges of the defect was incised and dissected until the fascia was reached. The liver was adherent to the surrounding tissues, and was separated by sharp and blunt dissection. Considerable bleeding occurred from the liver tissue. Several sutures were put in the liver for hemostasis and the organ was gently replaced into the abdominal cavity. A number of silk tension sutures were taken through the skin, fascia, muscle, and peritoneum. Traction was exerted on the tension sutures to facilitate the replacement of the liver into the abdominal cavity

Fig. 3, left. One month after operation. Showing healthy child. Note irregular abdominal scar.

Fig. 4. Shows well developed, healthy child at the age of 16 months. Note strong abdominal wall.

and to approximate the edges of the peritoneum, which was then closed by continuous plain catgut suture. The fascia was approximated with interrupted chromic gut sutures. The tension sutures were tied and interrupted silk sutures placed in the skin between them. In the first days following operation normal saline solution with 5 per cent glucose was given intravenously and by hypodermoclysis to provide fluids, after which the child was fed on breast milk and made a satisfactory gain in weight. She was discharged in good condition at the age of 1 month (Figs. 3 and 4).

This child was observed up to the age of 3 years and 1 month. On last examination (Fig. 5) she was found to be a healthy, sturdy child. The operative scar was strong and there was no sign of recurrence of the hernia. The mother has since had a third pregnancy with normal labor, giving birth to a healthy male child.

The cause of congenital umbilical hernia is now generally considered to be the failure of the primitive intestinal loop to withdraw into the abdominal cavity toward the end of the third month of embryonic life. Normally between the second and third month of embryonic development, this primitive loop develops within the umbilical sac and outside the abdominal cavity. By the end of the third month, the intestines normally are drawn into the abdominal cavity. However, if this fails to occur, the child is born with what Sir Arthur Keith calls "an uncured hernia at the navel," which may result in so large a defect in the abdominal wall that a

Fig. 5. Shows well developed, healthy and intelligent child of 3 years and 1 month.

large portion of abdominal viscera becomes herniated before birth.

Discussing Niebuhr's case, C. P. Bardeen notes that the embryonic gastroduodenal loop from which the liver and pancreas develop is never normally contained within the umbilical sac, so that if the liver is included in the sac when the child is born it must have been drawn down in a later period of fetal life, probably due to "a slow stretching of the ligaments of the liver."

What factors are responsible for the failure of the intestines or liver, in these cases, to withdraw normally from the cord into the abdominal cavity is not known with certainty. Bergglas has discussed various hypotheses in this connection. Until rather recently the view has received general acceptance that this failure is due to the pathologic persistence of the vitelline duct; but against this concept it is now urged that this duct has already dwindled down to a thin thread in the fifth week of embryonal life, when the embryo is only 5 to 7 millimeters long, whereas the development of the physiologic umbilical opening is not observed until the embryo is 30 to

40 millimeters long. Hence it cannot properly be related to the vitelline duct, nor would persistence of the latter explain the prolapse of large intestinal loops, liver, spleen, pancreas, etc. On the other hand, attempts have been made to relate it to defects of the abdominal wall; it has been claimed that the part of the hernial sac where the liver lies corresponds not to the dilated umbilical cord but to the supra-umbilical portion of the abdominal wall, which in these cases is faulty in its development.

Bergglas, while attaching importance to this view, thinks that an inhibition of the growth of the abdominal wall could not alone account for the presence of abdominal organs in the sac. He draws attention to a second factor of very great importance; namely, a marked disturbance in the relationship of the growth process of the abdominal *cavity* and that of the abdominal *contents*. Through lack of correlation, the cavity is too small and the visceral content too large. This disturbance of correlation would occur between the third and the tenth week, which represents the termination of the teratogenous period. The rather long time between these two periods would account for the existence of two types of congenital umbilical hernia that are observed; namely, one with an avascular membrane, which also covers the divergently coursing umbilical vessels, and another type in which the sac is composed of peritoneum. The first type is the commoner, and it is in these cases, which constitute the great majority, that immediate operation is of the greatest importance, for if no operation is carried out, the avascular membrane will become necrotic and the child will die. Other possible contributory factors hindering the abdominal organs from entering the abdominal cavity are hyperlordosis of the spinal column, and anomalies of the mesentery.

The presence of other associated anomalies or malformations is not infrequent in these cases. Aribat found these expressly mentioned in 20 of the 160 cases he collected; in all these cases the children were stillborn or died shortly after birth. In 1930 Gruber described 5 anatomical specimens showing congenital umbilical hernia associated with other malformations. Kleiner (1930) reports 2 cases of this kind; Smith (1932) 4; and Krumm (1931), Caffier (1933), and Ginglinger (1935) 1 case each.

In cases of this type an etiological factor has been sought in heredity, and there has been a widespread belief that congenital hernia in general is inherited and may run in families. In the case I am here reporting neither parent showed any signs or gave any history of congenital hernia, and, as has been noted, 2 other children in the same family were entirely normal, only the second of the 3 children exhibiting this malformation. One may, perhaps, emphasize the fact that all three pregnancies, labor, and puerperium were entirely normal with the exception of the congenital anomaly presented in the child of the second pregnancy.

A review of recent cases shows that the histories do not indicate any hereditary tendency to hernia of any kind in the families in question. Moreover, in most cases the pregnancy and labor are entirely normal, without any illness or trauma to explain this fetal maldevelopment.

As a rule, except in cases of very small congenital umbilical hernia, diagnosis presents no difficulty, the condition being self-evident as soon as the child is delivered. The hernial sac, which may consist of peritoneum, thin layer of Wharton's jelly and amnion, is often translucent, as in the case here reported, so that the contained viscera may readily be seen through it. The small intestines are usually present in the sac; portions of the large intestines are often included, and in some cases, as here, the liver too, or a considerable portion of it.

Among the 109 cases of congenital umbilical hernia tabulated by Altpeter, the liver was in the sac in 31 instances. This was true also in 14 of the 46 more recent cases reported since 1929.

A few instances have been recorded in which the sac had ruptured and the intestines lay free on the abdominal wall. Massabuau and Guibal reported such a case, and collected 22 similar cases from the literature. In some of these the sac was completely absent, in others only vestiges remained, while in still others

there was merely a tear in the sac. Their collection does not include any of the three early ones of this type reported by Hey, nor the recent case of Krumm (1931). In the latter, there was no hernial sac, and the liver as well as the intestines lay free on the abdominal wall. Other congenital deformities were present and the child died in 18 hours without operation.

The presence of an umbilical hernia, even though it be a large one, does not often affect the course of labor. Stoeckel notes that this is because the parts are soft. If, however, the umbilical cord is short, it will interfere with labor. In most of the instances reported it is expressly noted that labor was normal and delivery spontaneous, as in my own case. But that the umbilical hernia may occasionally cause some obstruction to labor is shown by a recent report from McCaughan, who writes:

"The delivery proceeded normally until the level of the umbilicus was reached, and there it was definitely retarded. The baby was breathing, so no effort was made to finish the delivery for several minutes. When pressure on the abdomen and slight traction failed to deliver the buttocks, a hand was slipped along the baby's abdomen, in the belief that there was probably a short cord preventing normal delivery, and the hernia was encountered. The newborn was flexed to right angles at the hip, with head and shoulders across the mother's symphysis, and delivery easily accomplished."

While it is probable that in olden times infants born with a large umbilical hernia died soon after birth, as the statements of Paré and Hamilton would suggest, some of those with small hernias undoubtedly survived, carrying their hernias into childhood or even into adult life. Unquestionably many of the infantile umbilical hernias mentioned by the earlier writers were actually of congenital origin.

One of the early methods of treatment appears to have been the application of a protective bandage without any attempt to reduce the hernia. Aribat lists some cases of this type, and in all probability this method was employed by many a midwife when the hernia was relatively small. Later on, various conservative methods were employed, in which the hernia was reduced and the reduction maintained by use of adhesive plaster or a compression bandage or by some method of disposal of the sac and closure of the abdominal wall.

In modern days, however, radical operation is almost universally considered the safest procedure in cases of large or massive hernia. Its essential features, as stated by Fraser, are "incision of the sac, separation and reduction of the contents, and closure of the abdominal wall," the exact technique depending upon the conditions found in the individual case and the judgment of the operator.

Cullen states that in all cases of congenital umbilical hernia except the very smallest, radical operation should be done at once. He points out that even if the intestines can be easily replaced by taxis within the abdominal cavity, the thin walled sac still persists, and as its walls are only amnion and peritoneum, they are likely to tear, and there will be danger of peritonitis.

Pybus points out the danger of strangulation of such a sac if it is not removed immediately by radical operation. There is also the possibility of its contents being injured when the cord is tied. Wherever the condition is amenable to operation he favors radical removal of the sac and cord, followed by closing of the enlarged umbilical ring. He has seen this type of malformation associated with ectopia of the bladder or imperforate rectum.

Notwithstanding a certain percentage of fatalities after radical operation, in the great majority of cases the child's best or only hope lies in this procedure.

Cumston points out that if these hernias are not operated on immediately after birth, there is danger of desiccation occurring, and becoming the starting point of infection and inflammatory attacks in the abdominal viscera. If operation is carefully performed at once, it is his opinion that babies will stand the operative shock very well. According to von Reuss and Parmelee, even where the sac has ruptured, an immediate operation may result favorably.

That radical operation is growing in favor and is giving an increasing percentage of cures

is evident from a comparison of recent statistics with those of an earlier date.

In only 68 of the 160 cases (40 per cent) cited by Aribat in 1901 had the radical operation been done, resulting in 47 recoveries, while of the 109 cases tabulated by Altpeter since 1900, 91 (90 per cent) had been operated on by a radical method with 69 recoveries. Of the 46 cases reported since 1929, all but 11 were submitted to radical operation. Four of these 11 cases were stillborn, 1 died immediately after birth, and 1, 18 hours after birth (with other congenital malformations); 4 were treated by a conservative operation, and 1 by Ahlfeld's alcohol method. This last child recovered and was in good health at the age of 7 months when it was accidentally killed. Of the 4 children treated by conservative operation, 3 recovered, 1 being reported as well at the age of 8 months.

Among the 35 cases in which radical operation was done there were only 5 deaths. Of those recovering after operation, 5 have been followed up for more than a year. The longest follow-up reported is that of Vogel, whose patient is entirely normal with the scar well healed at the age of 9 years. Ludwig reports 2 cases followed up 2½ and 5½ years, respectively. Gordon reports a child living and well 3 years after operation and Freshman a case well at 3½ years. Of the 45 cases in which the liver or a portion of it was stated to be herniated, 11 recovered; this includes the case of Ludwig followed up for 2½ years. In Niebuhr's case with both liver and gall bladder in the hernia, the child was well 3 months after radical operation.

Undoubtedly best results are obtained by radical operation within a few hours after birth. Newborn infants tolerate operation and anesthesia remarkably well. Friedrich, emphasizing this point, states that in his cases, the infant showed normal gain in weight after operation. In one of these the infant was premature and had an extensive hernia, yet rallied well from the operation and progressed as satisfactorily as any premature infant. At 4 months of age it was entirely normal, but died later of pneumonia.

If, however, the child is born outside the hospital and in some isolated community where it cannot be sent to the hospital immediately, a conservative method of treatment may be the only one possible, and instances are on record in which the results have been surprisingly good.

In 1899, Ahlfeld described a method by which the hernia was reduced as far as possible under light narcosis, after careful cleansing of the hernial sac and surrounding skin, and then alcohol compresses applied and covered by a bandage. In the first case he treated the liver was present in the hernial sac and complete reduction was impossible; yet the child thrived without operation, and a year later the scar was excised and the wound closed. This patient was known to be living and well at the age of 15 years. Few surgeons, however, would allow a case of this kind to go without operative intervention today. With a small hernia palliative measures may result in cure, but when the hernia is massive, radical operation is imperative and must be done without delay. As Dott graphically puts it: "The child should pass straight from the womb onto the operating table."

SUMMARY AND CONCLUSIONS

1. Massive congenital umbilical hernia is a rare surgical condition requiring immediate radical operation in the first hours following birth.

2. The literature on congenital umbilical hernia is reviewed.

3. A case is described in which a massive congenital hernia of the liver into the umbilical cord was successfully treated by radical operation 12 hours following the birth of the child.

4. Operative intervention and anesthesia were remarkably well borne by this infant.

5. The technique of operation employed in this case is described.

6. No grounds are found for a belief that congenital umbilical hernia is an inherited affection, or one that runs in families.

7. The case herein reported would refute the assumption that congenital umbilical hernia is an inherited affection, and the survey of the literature would indicate to my mind that there is no ground for such popular concept.

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THE INITIATION OF RESPIRATION IN ASPHYXIA NEONATORUM

A Clinical and Experimental Study Incorporating Fetal Blood Analyses

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THE initial gasp after birth (Fig. 1) is normally a vigorous inspiratory effort that opens the airways and some of the alveoli of the lungs. It is the most important event in every life, and is quite distinct from subsequent respirations. Once breathing, however irregular and shallow it may be, has developed, effective means of augmenting it are available. But there is no one generally accepted measure for initiating the first inspiration. If this does not occur spontaneously, the life or death of the child depends upon the measures employed.

The human fetus makes rhythmic respiratory movements *in utero* during the latter months of pregnancy. The onset of true respiration is believed to be caused by chemical rather than by physical factors. An explanation of this phenomenon satisfactory for our purpose is, that immediately after delivery, the placental circulation is markedly impaired by the contracting, retracting uterus. This results in a diminution of the oxygen supply to the baby and a marked increase of the carbon dioxide tension in the blood which stimulates the respiratory center to action. We are all born in a condition of apnea, but it is only when this state persists for an unduly long period of time that there is cause for alarm. In the majority of prolonged apneas the constant increase in the carbon dioxide tension plus the measures employed by the obstetrician result in an inspiratory gasp, and apprehension is relieved. More and more often this favorable outcome is not experienced so easily—sometimes, not at all. It is in an effort to face this problem that this paper is presented.

We shall deal only with severe cases of respiratory depression and asphyxia. Clinically most of them correspond to what is known as asphyxia pallida, which term will be frequently employed. At other times we shall use the word stillborn indicating in either case a baby in a state of shock, very pale with a relaxed musculature and absent superficial reflexes, which has not breathed, but in which the circulation persists. As far as treatment is concerned there is another class of babies: those which are so deeply narcotized and anesthetized as to be in serious danger. Although these are not in shock and are blue rather than white, such a severe degree of depression presents a problem almost as serious as that of true asphyxia pallida.

Since the literature is replete with studies of the etiology and pathology of asphyxia neonatorum, these phases will not be dwelt upon. It is important, however, to discuss briefly changes in the blood which are found in asphyxia neonatorum. It is only when such studies, at least as far as the oxygen content is concerned, are furnished that a true picture of the gravity of a case can be obtained, and the success or failure of the method of resuscitation properly evaluated. Eastman has shown that in severe degrees of asphyxia neonatorum there is a reduction in the oxygen content of the fetal blood to extremely low levels. He has shown also that the serum

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Fig. 1. Tracing of the first gasp and subsequent respiratory progress of a baby, born spontaneously of a mother to whom no drugs or anesthetics were administered. Tracing commences 12 seconds after delivery, the gasp occurs about 50 seconds later. Effect of peripheral stimulation is clearly shown. Lower part of graph obtained ½ hour later. Although the respirations are adequate for lung ventilation, they are still irregular.

hydrogen-ion concentration is markedly reduced, there being at the same time a considerable increase in the carbon dioxide tension with, usually, a moderate decrease in the carbon dioxide content. When the latter occurs, there is always an increase of endogenous lactic acid, sometimes to very high levels (45 to 90 milligrams per 100 cubic centimeters). Levels above the latter figure are practically always associated with fetal death. For several years previous to the publication of Eastman's studies we conducted similar investigations. Eastman's work was performed on blood from the umbilical artery and vein as well as blood from the maternal vein. He reported findings on normal and asphyxiated babies together with those born of deeply anesthetized mothers. Our studies were on the umbilical vein blood of normal and asphyxiated babies. The first group consisted largely of spontaneous births while the second was composed of many types of deliveries, the complicating effects of anesthesia and narcosis, as far as possible being avoided. The blood obtained under oil by a special technique, and analyzed by methods similar to those of Eastman, furnished results which paralleled his to a very close degree. An interesting finding in our series was the low oxygen content in some babies which appeared to be breathing fairly well (Fig. 10) while in a fatal case (Fig. 3) the oxygen content was below 1 volume per cent.

Pressure from the laity has forced the profession to increase the use of analgesia and anesthesia. In many hospitals few labors are carried through with no drugs whatever. From a clinical point of view, it must be admitted that, although the incorrect or excessive use of drugs may cause anxiety, as a rule such babies respond after a more or less prolonged period of apnea. Occasionally, however, a depression is encountered which is so deep that after a few shallow respirations the apnea recurs (Fig. 2) and such babies can be kept alive only with the greatest difficulty. The important point is, that although few lives are lost as a result of the use of drugs *per se*, such babies cannot stand much additional asphyxia. If in such cases obstruction occurs in the cord, or there is partial separation of the placenta, compression of the head with forceps, etc., plus a long, deep anesthesia, many of these babies will die. *They would often recover from the narcosis or the asphyxia alone, but are overwhelmed when one is superimposed upon the other.* If a traumatic delivery with deep anesthesia is anticipated, or other causes of asphyxia are present, or likely to occur, it would be safer to dispense with drugs.

THE INFLUENCE OF DRUGS ADMINISTERED TO THE MOTHER UPON THE ASPHYXIA OF THE NEWBORN

It is a poor use of drugs that, in sparing the mother pain, causes her to bear a baby that will not breathe. Resuscitation has an important place in the technique of the obstetrician, but it is best that it should be needed as seldom as possible. It is not always successful.

All anesthetics, hypnotics, and narcotics diminish the sensitivity to stimuli. But these drugs vary widely in the relative degrees to which they depress sensitivity to the various kinds of stimuli.

The two most important forms of stimuli that come into consideration in parturition are: first, those irritations of afferent nerves that produce pain; second, those chemical

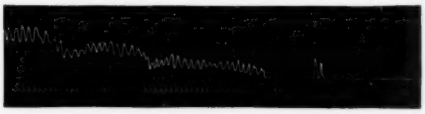

Fig. 2. Narcotized baby slowly relapsing into apnea. Respirations become progressively more shallow and the expiratory base line steadily falls. This indicates a decrease in muscle tonus and the closing of great numbers of alveoli as the chest wall collapses. This baby responded to carbon dioxide-oxygen inhalations after respirations were reinitiated.

Fig. 3. Tracing of an infant admitted after attempted forceps delivery at home. Ether anesthesia was used in a long, difficult high forceps delivery; baby was limp and white, and showed only a faint cardiac impulse. Every available method of resuscitation was employed without any improvement in color or tonus, weak respiratory efforts occurring at irregular intervals, however. Five minutes after delivery this tracing was obtained with the oxygen mask in place. Baby was removed from the pneumograph and treatment was continued. Patient died 20 minutes later. Autopsy was refused. Blood obtained from umbilical vein immediately after delivery showed the following: oxygen content, 0.8 volumes per cent; pH, 6.97.

stimuli that act upon respiration. In general the volatile anesthetics decrease sensitivity to afferent stimuli, while exerting comparatively little influence of a depressant character upon respiration unless administered in excess. Morphine (the drug traditionally relied upon to relieve pain by diminishing sensitivity to afferent stimuli) exerts a more powerful depressant effect in decreasing the sensitivity of the respiratory center to stimulation by the gases of the blood.

Obviously for use in parturition the drugs employed should have a maximum capacity to protect against pain with a minimum tendency to depress respiration. The failure to consider this point is probably due to the fact that until comparatively recent years the drugs chiefly employed were the volatile anesthetics. Beginning some 20 years ago, however, scopolamine with morphine came into use, and the more recent introduction of the barbituric acid compounds has led to a widespread and increasing practice of prolonged narcotization of the mother instead of temporary anesthesia.

Experience demonstrates that most drugs administered to the mother pass also to the child. Consequently the decrease of the sensitivity of the mother is accompanied by a decrease in the sensitivity of the respiratory center of the child to those chemical stimuli that normally induce and maintain respiration. How important this point is in actual practice is strikingly demonstrated by the figures recently published by Irving and his associates showing that, of all children born of wholly undrugged mothers, less than 2 per cent fail to breathe spontaneously; on the other hand with some of the drugs now frequently used, the depressant effects are so powerful that a large minority, or even a majority (35 to 65 per cent) of the children born under their influence fail to breathe immediately at birth. Doubtless no obstetrician would admit that the use of such drugs had in his experience, actually cost the life of a child, but considering the extent of the present use of powerful respiratory depressant drugs in labor, there can be no question that there is a considerable mortality from this cause. This does not take into consideration those babies which are successfully resuscitated, but which later develop pneumonia from a continuance of partial atelectasis.

As an approximation the amount of protection against pain in relation to depression of respiration from drugs and gases in common use is as follows: paraldehyde, nitrous oxide, ethylene, ether, chloroform, barbiturates, scopolamine-morphine, morphine. When morphine is used, it should be in moderate dosage and should not be administered less than 2 hours before delivery (Fig. 9). We have found experimentally and by clinical experience that babies are not easily depressed by the barbiturates, but if deep depression exists as the result of excessive dosage, the response, if any, to the administration of carbon dioxide is poor. Ether is relatively safe unless present in the blood in high concentration for a long period of time. Nitrous oxide is of little danger to the baby if 15 per cent or more of oxygen is administered with it. If the oxygen ratio is much below this, however, asphyxiation of both mother and baby will occur. The value of paraldehyde is becoming generally recognized; no other available drug is so harmless.

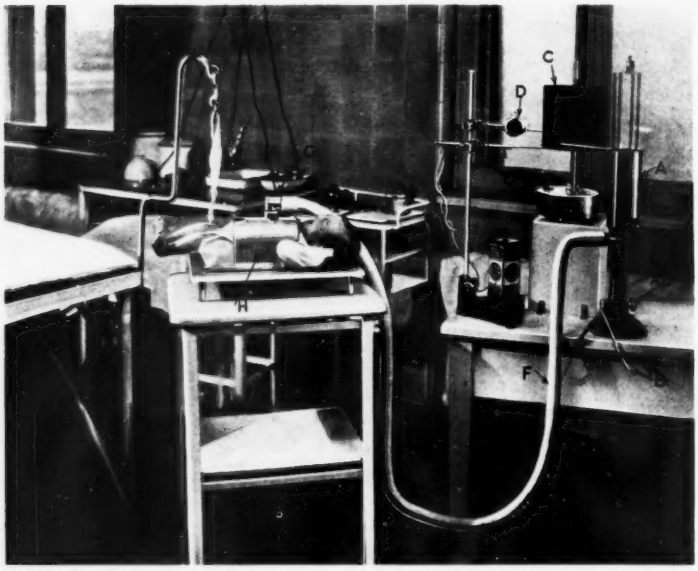

Fig. 4. Pneumograph connected to recording apparatus. (Baby 3 days old), *a*, Spirometer with scribing point in contact with revolving drum; *b*, clamp in place on small rubber tube through which air is forced into the system; *c*, recording drum; *d*, timer for recording seconds; *e*, electric timer; *f*, rubber tube; *g*, connection to which rubber bag is attached; *h*, hinged plate under which is inflatable rubber bag contacting front and sides of chest and abdomen. NOTE: When taking tracings immediately after delivery, the pneumograph should be nearer the delivery table, so that the cord need not be cut unless it is very short.

OLDER METHODS OF RESUSCITATION

Artificial respiration. Moncrieff states: "Artificial respiration in the sense of moving the chest even gently stands condemned in any form until respiration has begun, and once a breath has been taken, it is no longer necessary." It does not reflect credit on the profession that this measure still is advocated in most of the standard textbooks of obstetrics. Artificial respiration depends principally for its effectiveness upon compression and a resulting decrease in size of the thoracic cavity. If the alveoli contain air, some of it is expelled, so that when the pressure on the chest is removed, provided obstruction is not present, the elastic recoil plus the tonus of the diaphragm bring about an inspiration of air. It is of no avail to compress the unexpanded, solid, fetal lung, for upon releasing the pressure, air will not enter the dense viscus. In serious cases tonus is almost entirely absent, and if a little air has already entered the bronchial tree, compression further restores atelectasis.

Summary. Artificial respiration in the babies under consideration is condemned for its futility, exposure to cold, and the risk of injury. The peripheral stimuli which are, incidently, involved in the various methods, are quite useless because they do not reach the center. The necessary stimuli must be chemical rather than physical.

Mouth to mouth insufflation. This method of resuscitation dates back to antiquity. The principle involved is similar to that employed in the pulmotor and lungmotor. Mouth to mouth insufflation carries serious risk of infection and depends largely for success on the experience and skill of the operator. The latter's mouth serves as a mask and air is forced into the baby. It usually enters the stomach, but if sharp, short, repeated puffs are made, a little may enter the trachea, especially if the head is held in hyperextension.

Fig. 5. Manner of injecting a respiratory or cardiac stimulant into the umbilical vein. The cord has been clamped and cut about 8 inches from the umbilicus. To facilitate the insertion of the needle, if possible a dilated or bulbous portion of the vein should be selected. It is well to withdraw a little blood in order to be sure that the needle tip is within the lumen.

Fig. 6. Stripping of the umbilical cord. It is compressed between the fingers distal to the point of injection, and the fingers are then moved toward the umbilicus. The amount and rate of introduction of a drug into the general circulation are regulated according to the speed at which the fingers are moved.

Some observers believe that the carbon dioxide in the exhaled air which is between 3.7 and 5.5 per cent may be responsible for a favorable result. This is most unlikely. The oxygen (11 to 17 per cent) is of some value. This is indicated by improvement in the cardiac impulse sometimes noticed though no respirations occur. When a response is obtained, it is more apt to be due to the fact that a faint reflex is produced by the sudden distention of the larynx and trachea. In severe cases this reflex is not present so that the principal benefit that might be derived is from bringing into play the Hering-Breuer reflex by a marked distention of the bronchial tree. The pressure of air necessary to affect the stretch receptors, however, is likely to injure the delicate lung tissue.

Summary. In the hands of the novice it is always dangerous, and even after long experience, the possibility of ruptured alveoli and infection is great. Occasionally a baby is saved by its use. It should be reserved, however, as a last resort after all other methods have failed.

NEWER METHODS OF RESUSCITATION

In order to evaluate intelligently the methods at present available to initiate respiration it is important to describe briefly certain experimental work performed by us. It was done in an attempt to answer the following question: Can the alveoli be safely opened and made available for gaseous interchange by means of gases under pressure in the trachea and bronchial tree (intrinsic pressures)? Conditions closely approximating those found in the living but non-breathing newborn can be obtained by using true stillbirths. Our material consisted of full term stillbirths in which death occurred less than 3 hours before delivery. These were immediately intubated with a leak-proof tracheal tube and the bronchial tree distended by oxygen. Five cases are reported here, a number sufficient to answer the question just propounded. The first was intubated for 20 minutes, a continuous pressure of 18 millimeters of mercury being used; the other 4 with the same pressure applied intermittently —4 seconds on and 3 off. A pressure as high as 18 millimeters was used in order to insure the thorough distention of the bronchial tree. The babies were immediately subjected to autopsy and the lungs in all 5 cases presented grossly no evidence of aeration. They immediately sank when placed in water. This is the more remarkable if we bear in mind that during the insufflation the thoracic cage and, to a lesser degree, the abdomen, were rhythmically expanded and deflated in a manner similar to normal respiration. When these

Fig. 7. Blood pressure response of the cat to injection of lobeline hydrochloride 1/20 grain into the femoral vein. Amytal was given intraperitoneally in sufficient amount to prevent pain and struggling. Note the transient rise of pressure and increase of pulse pressure with subsequent slight fall below the base line. A return to normal is reached in 4 minutes.

and other cases in which the pressures ranged from 18 to 5 millimeters of mercury are published, the microscopic findings and concomitant photomicrographs will be given in detail. It is sufficient to state that only relatively few alveoli contained air. When air was found, the surrounding alveolar wall was usually torn, often communicating with other alveoli similarly damaged. Many were filled with blood. In 2 cases air blisters beneath the pleura were present, indicating extensive damage. The pressure was evidently too great for the friable fetal lung and resulted in serious damage, yet it was not adequate to aerate the lung and open the alveoli. It is logical to assume that a lower pressure, unlikely to damage the tissues, would be less effective in overcoming atelectasis. As a result of our experiments we can positively state that, although the bronchial tree can be thoroughly distended, the chest walls expanded, and the diaphragm displaced, the lung tissue itself cannot be adequately aerated even by pressures high enough to be injurious and destructive.

Drinker respirator. The efficacy of the Drinker respirator for respiratory depression in an adult or child which has breathed is beyond question. The important point in such cases is that alveoli are open so that, if respiratory movements are even an approximate prototype of the normal, air will enter and leave the alveolar spaces. Exposure is avoided, there is an absence of trauma and the rhythm is perfect. Although the respiratory movements are not exact duplicates of those controlled by impulses from the center, the imitation is close.

The diaphragm is an important factor in respiration, but with the Drinker respirator the amplitude of its descent is much less than in normal respiration. In spite of this, numerous reports are favorable and show that good ventilation can be maintained. When this instrument is properly used, in moderately depressed babies, similar favorable results are obtained. We are faced with a more difficult problem in the case of the baby which has never breathed. The collapsed lung of the newborn is a structure composed of the bronchial tree, alveoli, blood vessels, fibrous and elastic tissue. It contains no air and does not open suddenly when the chest is expanded, but, rather, in sections of varied extent. With each early inspiration additional alveoli are aerated and, as this continues, more and more blood from the pulmonary artery circulates in the peri-alveolar capillaries. Gaseous interchange between the alveolar air and the blood now takes place so that increasing amounts of oxygen are carried to the center. Roentgenograms show that days and even weeks may elapse before the lung is completely expanded.

Coryllos and Birnbaum found a pressure of 14 centimeters of water necessary to inflate the atelectatic lung of the dog. This pressure was required solely to overcome the cohesion between the opposing surfaces of the collapsed alveoli. It does not take into account the additional pressure needed to overcome the resistance of the chest wall and diaphragm. This introduces an important principle, namely, that the initial effort necessary to expand the lungs must be considerably greater than the subsequent efforts required to maintain the expansion and continue ventilation.

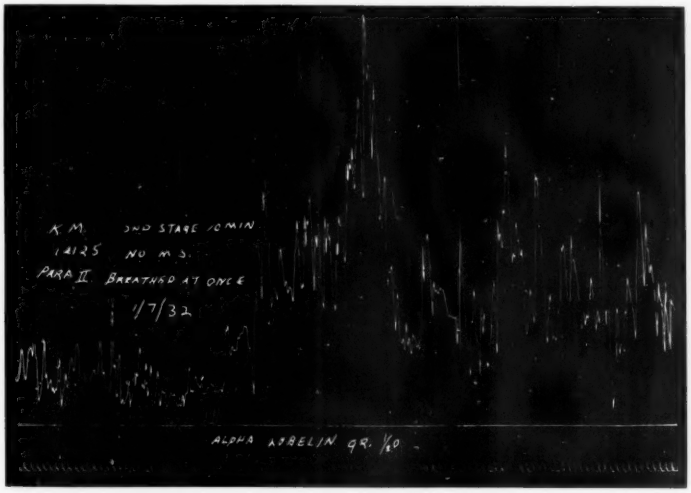

Fig. 8. K. M. No. 12125; weight, 7 pounds 12 ounces; gestation, 9 months; labor, 7 hours 30 minutes; second stage, 10 minutes. No morphine or anesthetic was used. Delivery was spontaneous. Baby was in excellent condition, breathed immediately. Lobeline hydrochloride, 1/20 grain, was injected 3 minutes after delivery for purposes of demonstration. This tracing shows a baby breathing irregularly but satisfactorily. A few seconds after injection a tremendous increase in the amplitude of most of the respirations commences. These extensive excursions of the thoracic wall result in the aeration of many additional alveoli, with a proportional increase in pulmonary ventilation.

It should be clearly understood that we are only evaluating the use of the Drinker respirator for initiating respiration. Murphy, Wilson, and Bowman in 1931 reported the results in 35 infants treated with this apparatus. In 1932 Murphy and Sessums reported a larger series of 66 infants who failed to breathe promptly at birth. After careful clearing of the air passages the instrument was adjusted to give a breathing rate of 45 per minute for one group and 35 per minute for the other. The negative pressure employed was from 8 to 10 centimeters of water. Analysis of the results reported by these workers is not impressive. Fifteen of the 66 infants never breathed and 21 breathed before or during treatment only to die in the hospital. Although at least 13 of the 36 failures were premature, and most of these non-viable, the cause of death in as many as 15 full term or only slightly premature babies is reported as cerebral hemorrhage. Tentorial tears were observed in 5 of the cerebral injury cases, each of which was a breech delivery, but no mention is made of the extent or location of the hemorrhage in these or the remaining 10, and, as cerebral hemorrhages are a common finding in asphyxial stillbirths (this condition being shown by Leff to be a result rather than a cause in most instances), death is not necessarily explained. In these deaths and others listed as being due to prolonged labor, prolapsed cord, etc., the important evidence as far as this method of resuscitation is concerned, namely, the extent of lung aeration, is not mentioned.

In 1933 Murphy and Bauer did report the results of postmortem examinations on the thoracic cavities of infants who died after treatment with a negative pressure of 8 to 10 centimeters of water. They were disappointed to find a high proportion of cases in which large areas of lung were unexpanded. They suggested, as a result of these findings, that better results would probably be obtained if a greater negative pressure were used. In view of these results and of others equally disappointing received in personal communica-

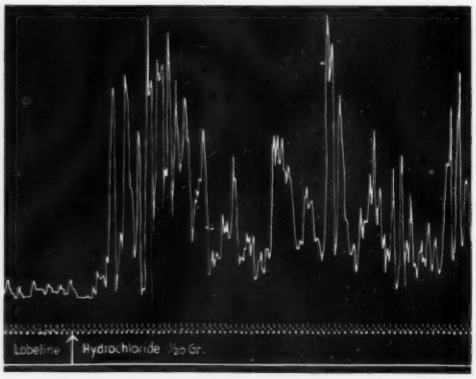

Fig. 9. Response of a morphinized baby, unexpectedly born 50 minutes after ¼ grain of morphine sulphate had been administered to the mother. Delivery was spontaneous. No anesthetic was used. Baby was blue but manifested good tonus. Cardiac impulse was slow, regular, and strong. Graph was started 3 minutes after delivery—note the slow and shallow respirations with a tendency of expiration to lag. Expiratory lagging is a form of respiratory depression often encountered in drugged babies. There are short periods of expiratory apnea. Such infants unless treated vigorously suffer from atelectasis and are subject to neonatal pneumonia.

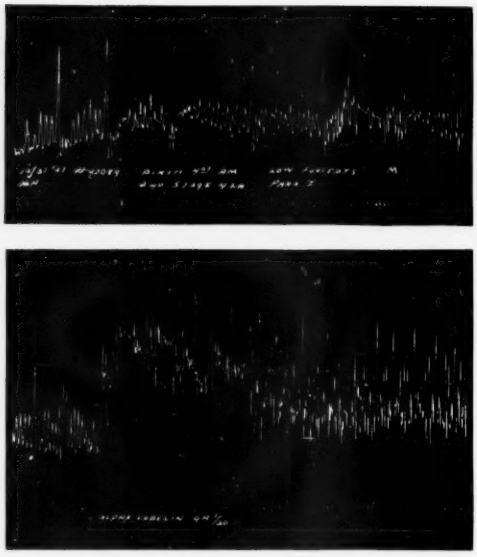

Fig. 10. N. H. No. 12089; weight, 8 pounds 3 ounces; gestation, 9 months; labor, 46½ hours; 1/6 grain morphine sulphate, 12 hours before delivery. Ether anesthesia was used. Delivery was by low forceps. Baby breathed promptly and although blue, appeared to be in good condition. Tracing was started 12 seconds after delivery. A specimen of blood obtained 30 seconds later showed only 4.1 volumes per cent of oxygen. Two and one-half minutes after delivery, 1/20 grain lobeline hydrochloride was injected to augment respiration. There is an increase in pulmonary ventilation of about 310 per cent, the greatest we have yet recorded. Of interest also is the comparatively low oxygen content in spite of little clinical evidence of asphyxia.

tions, it is evident that the negative pressure should be increased. Serious damage, however, can be inflicted by high degrees of negative pressure, since it is possible to expand the chest to such an extent as to rupture every alveolus in the lungs. It has been suggested that better results would be obtained if, in addition to a greater negative pressure, an alternating positive pressure were substituted for the return to atmospheric levels. This is not difficult to accomplish and is undoubtedly an improvement. The objection, even if this is done, that the patency of the air passages is not properly maintained, can be overcome by the simultaneous use of a tracheal tube. The principal difficulty is that, even in conjunction with a tracheal tube and alternating positive pressure, the initiating negative pressure necessary to expand the collapsed lung is greater than has yet been suggested, and cannot be known until extensive experimentation has been performed. Assuming that the expansion is accomplished by an adequate but safe pressure, it would then be important to diminish immediately the expansion force. This would make a trained attendant a necessity. The respirator is cumbersome and expensive, so that even if the technique is eventually perfected, it could hardly be available in many deliveries.

Summary. The Drinker respirator as employed today has little if any place in the initiation of respiration in the newborn. Piper, after years of use and observation with the Drinker respirator, came to the following conclusion: "This method of resuscitation based upon the principle of a vacuum can be of no value in those cases either blocked by a mucous plug or in which there is a definite condition of atelectasis. On the other hand, we are convinced that the Drinker apparatus for infants is of great value for the reviving of the newborn infant which has once had normal respiratory action." This is seen in prema-

tures who sometimes have syncopal attacks in the respiratory center, and deeply narcotized babies who breathe for a time and then relapse into apnea (Fig. 2).

Lungmotors — pulmotors — resuscitators. These machines are of two types: those employing intermittent positive pressure and those using intermittent positive and negative pressures. It is not within the scope of this paper to consider their value for the adult or the child which has previously breathed; we are concerned only with the baby which has had no respiratory action and appears unlikely to breathe without definite assistance.

For many years the idea of blowing air or oxygen into the lungs has appealed to science. The earlier pulmotors were given an extensive and fair trial and, possibly, did save some lives. They have been condemned on at least two occasions, however, by eminent commissions appointed to investigate their claims, and are little used today. The damage inflicted on the living subject and the number of lives lost because of the delay in instituting other measures will never be known. Brickley is quoted as having found tears and hemorrhages in the lungs of animals following their use. There is no question that many of the resuscitators on the market today are superior to the original pulmotors. They are safeguarded against excessive pressures, but the reasons which counsel their abandonment have not changed. On March 14, 1935, an English authority, Moncrieff, speaking before the Royal College of Physicians in London, on respiratory failure and resuscitative measures, stated: "Positive pressure inhalatory methods involving the use of a mask and pump are unsafe in most instances and quite unsuitable." Most of these machines are clumsy and expensive and even if they were efficient, would not be commonly found in smaller hospitals, and would practically never be on hand in the home where the majority of deliveries still occur.

Kreiselman, Kane, and Swope have reported good results with a resuscitator which they designed and developed. By means of a tube running to the back of the mouth, attached to a tight fitting rubber mask, repeated blasts of oxygen are injected under carefully regulated pressures. Its mode of action appears to be identical with that described under mouth to mouth insufflation without the disadvantages and dangers of the latter. In order to evaluate their work properly, detailed, microscopic studies on the lungs of fresh stillbirths treated with this machine and then immediately subjected to autopsy should be published. This also applies to any resuscitator which is claimed to open alveoli.

It is not difficult to account for the good results reported by some clinicians in their experience with resuscitators. If the apparatus employs positive and negative pressures, as most of them do, it is generally demonstrated by means of a non-elastic bag made of rubberized fabric. The bag is inflated until it resists further distention and creates a back pressure which then actuates a reversing mechanism so that an aspirator is brought into play and suction produced. When the bag is empty, the aspirator is automatically shut off, and inflation is again instituted. The bag is thus successively inflated and deflated. Inflation and deflation of a bag is deceptive, because the bag, unlike the air passages of the body, offers no resistance until full. As soon as the inspiratory blast meets an obstacle in the air passages, it is automatically cut off and turned into expiration, thus efficient inspirations are not performed. There follows a rapid clicking of the mechanism back and forth without any visible excursions of the chest and abdomen. Some observers believe that alveoli are gradually opened during this clicking process, but from our experiments on fresh stillbirths we are convinced that the alveoli cannot be opened in this manner.

When the opportunity to try out a new resuscitator presents itself, some obstetricians are likely to use it on baby after baby, which after delivery present a period of apnea, regardless of whether such treatment is really necessary (i.e., relaxed musculature, shock, absence of reflexes, failing circulation). As comparatively few babies manifest these findings but, rather, a mild depression as the result of drugs and anesthesia, it is inevitable that the results will be good. An objection to the use of these machines is that valuable time is lost before such instruments are put aside.

The lapse of even one minute in the case of a severely damaged respiratory center will result in further damage and may render the cells irreversible. Schmidt believes this to be due largely to the accumulation of products of incomplete oxidation. Once it has occurred, the full restoration of oxygen will fail to bring back functional activity because the altered cells are no longer able to utilize the gas.

Summary. At times resuscitators appear to give results in cases for which they are not needed. They fail in the serious cases under consideration and are contra-indicated if they employ suction, for if this acts at all, it tends to deflate the lungs and restore them to atelectasis.

Inhalators. The treatment of asphyxia with an inhalator usually consists of the inhalation of varying percentages of carbon dioxide and oxygen. Oxygen not only nourishes but sensitizes the cells of the respiratory center, while carbon dioxide, if present in sufficient quantity, stimulates them. Respiratory stimulation may be reflex or chemical. This form of treatment relies on the latter. Without going deeply into the chemical control of respiration it should be pointed out that, although a slight diminution in the oxygen content of the blood temporarily stimulates the center, a further diminution renders it less sensitive to whatever carbon dioxide is present. When this condition persists, oxygen should be restored as rapidly as possible, but, until this has been accomplished, an increase in the carbon dioxide tension will provide increased stimulation and largely compensate for the oxygen lack. If the oxygen content remains relatively low for a long period of time, which is the case in the later months of gestation, a considerable increase in the carbon dioxide pressure, a normal finding during these months, may not be adequate to initiate or continue respirations, as it has been shown by Eastman that the fetal center becomes dulled or insensitive to considerably increased tensions of carbon dioxide. In order to improve the function of the center the oxygen supply must be fully restored and, for a time, the carbon dioxide tension, already high, markedly increased. It is, in part, upon these facts that the value of the inhalator for the poorly breathing baby is based. As a rule a mixture of carbon dioxide and oxygen containing 10 per cent of the former is sufficient to augment respiratory movements, but in some few cases in which the respirations are very shallow, in spite of a high carbon dioxide tension, mixtures containing as much as 20 or even 30 per cent should be employed for a short time. As the oxygen revivifies the center, less carbon dioxide is needed; thus it should be progressively cut down to 10 or 7 per cent.

As early as 1920 Henderson (15) advocated the use of such mixtures. On numerous occasions since, he and many others have elaborated upon the subject so that, as far as the asphyxiated but breathing baby is concerned, inhalator therapy, when obtainable, has practically supplanted other methods. In such a case we rely on the infant inhaling the gases, thus producing stimulation as well as oxygenation of the center. The inhalator has saved, and will continue to save, countless babies, yet it can actually do harm. This statement is based upon the fact that the inhalator is useless in a stillborn child, for, placing a mask over a baby's face, even when the gas is under pressure, will not assure its entering the lungs. Valuable time is thus lost if the limitations of the inhalator are not appreciated.

Summary. The inhalator is the best and safest means we have for saving the life of the asphyxiated but breathing baby, and is also of value as a neonatal treatment for the prevention of atelectasis and pneumonia. It is, however, of no avail in itself as a means of initiating respiration (Cases 7 and 10, Table I).

Laryngeal intubation and insufflation. The digital insertion of a flexible rubber tube into the trachea has been practiced for many years, ease of introduction depending principally on the presence or absence of a laryngeal reflex. If present, it indicates a comparatively mild asphyxia, so that although insertion might be difficult, it is rarely needed. When the reflex is absent, there are no respiratory efforts and the skeletal muscles are markedly atonic. Because of this such babies can be intubated with little practice—DeLee, for example, mentions a simple technique. In 1928 Flagg described a technique for introducing a metal

tube into the trachea by means of a small electrically lighted laryngoscope. The tracheal tube is connected to a water manometer which is in turn connected with a supply of carbon dioxide and oxygen. The manometer indicates the pressure of the gases in the tube and is so adjusted as to act as a blow-off valve if an excessive pressure is used. We have found that 12 millimeters of mercury is the highest pressure that can be used with safety. Blaikley and Gibberd have recently suggested a somewhat similar technique employing a rubber catheter instead of the rigid tube. Although trauma may be inflicted if the laryngeal reflex is present, in its absence both methods are easy and safe.

The lungs of the stillborn are dark in color, do not crepitate, and sink in water. With the first inspiration the thoracic wall expands and the diaphragm descends so that a disproportion is created between the thoracic cavity and the solid lungs. In the absence of obstruction, air enters the bronchial tree and infiltrates into the alveoli. There is little or no negative pressure in the pleural space at this time, since insufficient disproportion between the lungs and the chest cavity exists. Later, as a result of the rapid growth of the ribs and vertebral column, a real disproportion is present, which, because of the elastic recoil of the lung tissue, produces a definite intrapleural negative pressure.

To most obstetricians intratracheal insufflation has for its principal object the forcible expansion of the lungs. It has been previously stated that the alveoli cannot be safely opened in this manner. The preceding paragraph described nature's way of opening the lungs, which, in most respects, is at variance with the concept of using gases under pressure in the trachea.

This does not mean that insufflation is not of great value. On several occasions we have observed that when oxygen is insufflated into the trachea, there is a definite improvement in color. If the insufflation is performed with a tight fitting tube and a pressure as low as 5 millimeters of mercury, the bronchial tree is distended, the chest increased in size, and the absorption of oxygen is even more rapid. Using this pressure and technique we kept a baby alive for 2 hours although it never breathed and autopsy revealed no open alveoli. This is of great significance. Intermittent pressure is recommended by Flagg but Blaikley and Gibberd state that this is not necessary. They feel that if respiration commences, expiratory movements against a positive pressure assist in the aeration of alveoli and to some extent are imitations of the valuable crying efforts. Intermittent pressure is probably of value, however, as the rhythmic expansion of the bronchial tree may bring into play the Hering-Breuer reflex. Although this reflex is absent in severe cases, it will return if the circulation improves sufficiently as a result of *the absorption of oxygen by the mucosa lining the trachea and bronchioles.*

Summary. Intubation is safe and easy to accomplish in the severely asphyxiated baby, permitting thorough aspiration and providing an excellent airway. Essentially, it is the extension of an inhalator into the lungs. It should not be used in an attempt to open the alveoli by direct attack.

Tilting boards. Eve and Cornish have devised seesaws on which the patient is laid and rocked through an angle of 30 or more degrees. Henderson (14) in recent experiments on dogs found that the volume of air moved in and out of the lungs by this rocking method is much less than that displaced when the chest is compressed by hand. As such pressure is useless when there is no air to expel, it would seem that the rocking method is of little or no value in initiating respiration.

Intravenous resuscitation. By this is meant the initiation or reinitiation of respiration utilizing a substance injected into the blood stream. This method depends principally either upon direct stimulation of the respiratory center or the lowering of the response threshold so that a previously dulled center is rendered more sensitive to the prevailing carbon dioxide in the blood. In 1928 one of us (R.A.W., 39) presented a preliminary report on the injection of a respiratory stimulant into the umbilical vein for the treatment of asphyxia neonatorum.

In the search for a satisfactory agent much time was devoted to the study of drugs com-

TABLE I.—SUMMARY OF THE IMPORTANT FACTS CONCERNING THE RESUSCITATION ON TEN NEWBORN INFANTS SUFFERING FROM ASPHYXIA PALLIDA

Infant	Cause of asphyxia	Delivery	Cardiac impulse	Oxygen content (volumes per cent)	pH	Simple measures of resuscitation (minutes)	Dose of lobeline (grains)	Elapsed time from stripping to first inspiration (seconds)	Response	Auxiliary measures	Approximate interval before rhythmic breathing	Subsequent treatment	Last observation
1 Term	Breach delivery. 14 minutes elapsed from appearance of umbilicus until head delivered. Extended arm	A.C.H.F.*	Barely noticeable	1.6	7.08	1	1/10	8	Slight stiffening of arms. Marked opisthotonus. Faint gasp, short apnea, 2 more weak gasps, short apnea, numerous irregular respirations	Heat. Traction on tongue with clamp. Inhalator after 3rd gasp. (CO_2 7%-O_2 93%)	2 hours	Inhalations of CO_2 7%-O_2 93% 5 minutes twice daily for 5 days	13th day normal
2 Term	Head caught in uterine incision 3 to 4 minutes	Classical cesarean section	Very slow but regular. Fair quality			5 Plus (Including mouth to mouth insufflation.) No response. Condition desperate	2/10	9	Marked stiffening. Irregular sudden inspirations with unco-ordinated movements of head and neck	Heat. Pure O_2 from funnel for 5 minutes after respirations initiated	30 min.	None	12th day normal
3 Premature 7½ mo.	Undetermined. Fetal heart sounds which had been strong and regular suddenly disappeared exactly 10 minutes before delivery	Mid-forceps	Imperceptible?	.8	7.02	1	1/20	7	Slight stiffening entire body. Weak gasp followed by shallow, irregular respirations quickly improving in depth and regularity. Immediate improvement in color	Heat only	40 min.	Inhalations of CO_2 5%-O_2 95% 5 minutes twice daily for 3 days	24th day normal
4 Term	Undetermined	Spontaneous L.O.A.	Barely perceptible. Very slow and irregular	3.2	7.15	3–4 (Including mouth to mouth insufflation.) No response. Condition grave	3/40	10	Slight opisthotonus. Deep vigorous inspiration followed by apnea for 30 seconds, then irregular but adequate respirations	Heat. Inhalator after respirations established	30 min.	None	12th day normal
5 Term	Premature separation of placenta	Low forceps	Slow and faint	2.8	7.12	3 No response	2/10	10	Vigorous inspiration. Rapid deep respirations with heaving of chest and abdomen	None	15 min.	None	12th day normal
6 Term	Breach extraction			3.2	7.14	1	2/10	8	Gasp and frequent deep respirations	Oxygen by funnel for several minutes after respirations commenced	15 min.	None	11th day normal

Average oxygen content.....1.955 volumes per cent
Average pH 7.096

*A.C.H.F.—after coming head, forceps

TABLE I.—SUMMARY OF THE IMPORTANT FACTS CONCERNING THE RESUSCITATION ON TEN NEWBORN INFANTS SUFFERING FROM ASPHYXIA PALLIDA—Continued

Infant	Cause of asphyxia	Delivery	Cardiac impulse	Oxygen content (volumes per cent)	pH	Simple measures of resuscitation (minutes)	Dose of lobeline (grains)	Elapsed time from stripping to first inspiration (seconds)	Response	Auxiliary measures	Approximate interval before rhythmic breathing	Subsequent treatment	Last observation
7 Term	3 loops of cord around neck. Fetal heart irregular for 3 hours before delivery. Very slow and faint for last half hour. Not heard during pains. Forceps extraction	Difficult mid-forceps	Very slow and faint (15 per minute)	.6	7.02	5 Plus Thorough suction. Clamp on tongue. Frequent slapping. Mouth to mouth insufflation. (3 attempts) Artificial respiration by pressure on chest and abdomen with inhalator over mouth and nose. (Rhythmic compression of inhalator bag). No response	1/20	9	After failure of previous methods, intravenous therapy attempted. Cord short and vessels collapsed. Reverse stripping permitted successful injection. Milked into general circulation. Death was imminent. Very slight increase of tonus followed by weak gasp. Short apnea then weak, irregular respirations. These improved slowly when inhalator reapplied	Heat. Inhalations of CO_2 7%–O_2 93% for 30 minutes	12 hours	CO_2 7%–O_2 93% 5 minutes every 2 hours for 24 hours. 5 minutes twice daily for 8 days. whiskey strychnine	13th day normal
8 Term	Breach extraction. Impacted shoulders. Extended arms		Slow and weak	3.6	7.20	2–3 No response	3/40	Less than 10	Deep inspiration followed by deep irregular respirations			Continuous O_2 by funnel. Spinal tap	Died after 22 hours. Cerebral hemorrhage with tentorial tear Autopsy
9 Term	Difficult breach extraction	A.C.H.F.*	Imperceptible?	1.0	7.06	1–2 No response	1/20	6–7	Stiffening of body. Weak gasp followed by several shallow respirations. Sudden improvement in color and deepening of respirations. Latter became labored just before withdrawal of tracheal sound. Cardiac impulse rapid and strong. Complete restoration of tonus	Tracheal sound. (Flagg) CO_2 20%–O_2 80% intermittently for ½ minute. (5 mm. mercury). Cord then stripped. Above continued for 1 minute after initial gasp. Sound withdrawn and inhalator applied. CO_2 7%–O_2 93% for 5 minutes. Repeated 15 minutes later. (Combination technique)	90 min.	Inhalations CO_2 7%–O_2 93% 5 minutes twice daily for 5 days	12th day normal except for fractured clavicle
Average oxygen content.....1.955 volumes per cent Average pH 7.096													

*A.C.H.F.—after coming head, forceps

TABLE I.—SUMMARY OF THE IMPORTANT FACTS CONCERNING THE RESUSCITATION ON TEN NEWBORN INFANTS SUFFERING FROM ASPHYXIA PALLIDA—Continued

Infant	Cause of asphyxia	Delivery	Cardiac impulse	Oxygen content (volumes per cent)	pH	Simple measures of resuscitation (minutes)	Dose of lobeline (grains)	Elapsed time from stripping to first inspiration (seconds)	Response	Auxiliary measures	Approximate interval before rhythmic breathing	Subsequent treatment	Last observation
19 Term	Long dry labor. Cord tight around neck	Difficult low forceps	Slow faint and irregular	.8	7.08	4. Plus Including traction on tongue and artificial respiration with inhalator over mouth and nose. Pulse increased and heart action became more feeble. Combination technique then employed. A total of from 8–10 minutes elapsed before cord was stripped. Sound in position in trachea. Prognosis doubtful	⅛	6	Marked stiffening of body and mild opisthotonus. Deep inspiration with moderate period of apnea. Several double inspirations and then respirations of increasing vigor, depth and frequency. Removal of sound followed by irregular sighing movements. With inhalator in place improvement was progressive	(Combination technique) Similar to preceding case except inhalator used for 15 minutes	Several hours	Inhalations of CO, 7% O_2 93% 5 minutes twice daily for 3 days	14th day normal
Average oxygen content.....1.955 volumes per cent Average pH 7.090													

monly deemed to be analeptics and respiratory stimulants, such as: strychnine, epinephrin, caffeine sodio-benzoate, atropine, ephedrine, etc. Either there was no respiratory stimulation following injection or so little that they would be of little use in a severely asphyxiated baby. Undesirable and dangerous side actions were often found, particularly with the dosage increased in order to obtain more respiratory effects.

It is necessary to summarize the results of hundreds of animal experiments in different types and degrees of narcosis and asphyxia in a short space: Only two drugs were found to be good respiratory stimulants: Pyridine B -carbonic acid diethylamide (coramine) and lobeline hydrochloride. The former increased considerably the rate and amplitude of respiratory movements. On a number of occasions it initiated respiration after the experimental production of apnea. Frequently, however, severe and sometimes fatal convulsions occurred even when recommended dosage was used. Moncrieff speaks of similar convulsions in children; therefore we have not felt justified in using it intravenously in the newborn. These convulsions do not usually occur in adults and older children when the drug is injected subcutaneously. No further consideration was given to coramine as the subcutaneous injection of this or any other drug in stillborn babies is doomed to frequent failure because of the weak circulation and the consequent lapse of time which results between injection and effect. If a favorable result is to be obtained, within a few seconds after injection, it is possible only by intravenous therapy. (Pentamethylentetrazol—metrazol and picrotoxin are known to be analeptics. In the case of the newborn extreme caution is advisable for these drugs are also convulsants.)

There is general agreement among those who have had experience with lobeline that it stimulates respiration. There is some difference of opinion as to its effectiveness in severe degrees of narcosis and asphyxia. Competent observers (1, 6, 8, 10, 16, 32, 33, 35, 36, 37, 38, 39, 40) have reported more or less favorably, yet others (11, 18, 20, 22, 27, 28, 31, 34) advised against its use. We have given it a

thorough and impartial trial both clinically and in the laboratory, using a preparation of lobeline hydrochloride.[1] The results as a whole have been impressive, especially in severe asphyxias.

Graphs of the apnea and early respirations of the newborn have not been previously produced, yet they are absolutely necessary if we wish to have impartial and permanent evidence of the condition of a baby before and after resuscitation. As there was no reliable method for recording the respiration of the newborn immediately after birth, it was necessary to devise an apparatus for that purpose. It consists of a receptacle in which the infant is placed immediately after delivery. Movements of an infant's chest and abdomen are transmitted to a spirometer carrying a scribing point which in turn writes on a drum (Fig. 4). By means of this apparatus it is possible to study, not only the effects of drugs and gases as resuscitant agents, but also the effect on the baby of drugs and anesthetics administered to the mother before delivery. Tracings can be started as soon as 7 seconds after delivery and from dozens which have so far been obtained a few representative ones will be presented.

In the remainder of this article we shall prove by means of the aforementioned graphs that lobeline will heighten the respiratory efficiency of the normally breathing baby; that it will rapidly overcome respiratory depression due to morphine; that it will produce such a marked expansion of the thoracic cavity as to greatly diminish, if not entirely remove, residual atelectasis; lastly, that it will actually initiate respirations in serious asphyxias. The graphs of the latter condition are fortified by detailed protocols of the resuscitation of 10 cases of asphyxia pallida with concomitant fetal blood studies (Table I). The best technique of injection, blood pressure response, method of action, dosage, and safety will be considered.

In order to duplicate these results the drug must be introduced directly into the blood stream, a most rapid method for reaching the center. Even in the breathing child, carbon dioxide administered with an inhalator finally reaches the center in this way. (Its entrance into the lungs and passage through the alveolar walls is an intermediate step.) Therefore, it is logical to introduce the stimulating substance directly into the blood if, as it has been previously shown, the lungs are solid. In grave asphyxias the lingual death zone is a barrier to the passage of gases into the trachea. The desired effect need be of short duration only because, if respiration commences and the airways are patent, a few inspirations will open up alveoli to oxygen and carbon dioxide. Treatment is then continued as it would be on any asphyxiated but breathing baby.

Any method of resuscitation should be as simple as possible. This is particularly true in obstetrics because so many deliveries take place in the home. One should also keep in mind the confusion and excitement that often attends the birth of a stillborn child. The superficial veins are too small to be readily available, and injection into the longitudinal sinus or heart chamber are radical procedures and should not be lightly undertaken. The umbilical vein offers the most convenient place of injection. Only when the cord has

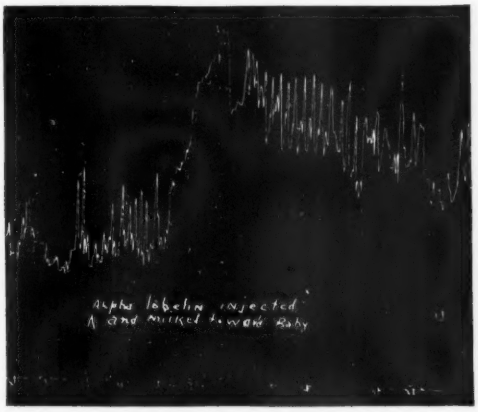

Fig. 11. E. S. No. 12543, weight, 6 pounds 1 ounce; gestation, 9 months; labor, 19 hours. Delivery was spontaneous. No anesthetic was used. Cord was twice around neck. Baby breathed at once, but remained blue. Three minutes after delivery 3/40 grain lobeline hydrochloride was injected. Note marked expansion of thorax which indicates that any atelectasis has been, at least partially, overcome.

[1]For a detailed history and description of this drug, the reader is referred to the standard textbooks of pharmacology.

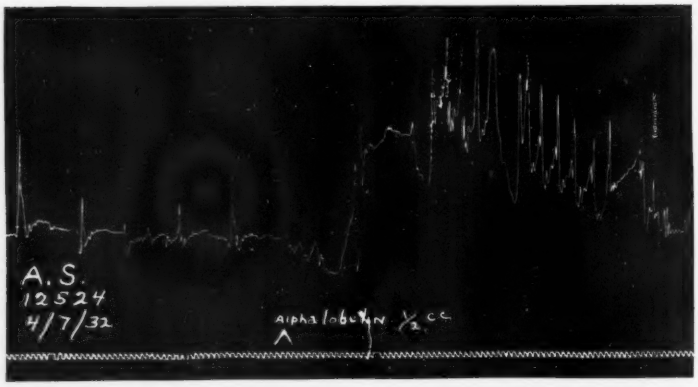

Fig. 12. A. S. No. 12524; weight, 7 pounds 12 ounces; gestation, 9 months; labor, 16 hours—1/6 grain morphine sulphate was given, 6 hours before delivery. Ether anesthesia was given. Delivery was difficult, by low forceps. Baby showed severe asphyxia, was limp and pale. However, faint efforts at respiration followed aspiration. Lobeline hydrochloride, 3/40 grain, was administered. Tracing was started 20 seconds after delivery. This baby was markedly depressed, the respirations consisting of irregular, gasping efforts. Following injection, the status completely changed. There is a marked expansion of the chest; true, deep respirations were established with good pulmonary ventilation. Recovery was complete. The umbilical vein blood contained 2.3 volumes per cent of oxygen.

been cut close to the child need other sites be considered. We make it a practice always to leave the cord long until respirations are well established.

The following improved technique is the one recommended for general use. Although not difficult, it must be correctly understood and performed in order to obtain a speedy and satisfactory response:

Immediately after delivery the baby is handed to an assistant who holds it preferably by the feet with the head down. The cord should not be cut unless it interferes with delivery or is very short. As previously mentioned it should not be cut close to the umbilicus. Thorough aspiration with a flexible rubber tube is performed, after which a careful appraisal of the baby is made. Particular attention should be paid to the color, muscle tonus, and the strength and rate of the cardiac impulse. If resuscitation is decided upon, the cord is inspected and a good injection site determined. This should be preferably between 6 and 8 inches from the umbilicus. The cord is then doubly clamped about 1½ inches distal to the chosen injection site and cut between the clamps. The remainder of the technique may be carried out on a table or in a heated receptacle, but we prefer to perform it without moving the baby, keeping it in its inverted position. There is less delay and less danger of a break in asepsis. An exception to this is made in the case of grave asphyxias in which a more elaborate technique in conjunction with a tracheal tube is used. This will be described later. If lobeline is the resuscitating agent to be used, 1/20 grain of the hydrochloride is injected into the umbilical vein (Fig. 5) and the cord compressed firmly between the first and second fingers adjacent to the clamp. The column of blood and drug in the vein is milked toward the umbilicus (Fig. 6). (Epinephrin and other drugs may be similarly administered.) The first half of the stripping is done rapidly to avoid delay. (The drug has not yet reached the child.) The milking is then continued slowly and progressively until a respiratory response results. Once breathing is well established, any drug remaining in the vein is removed by tying and cutting the cord near the umbilicus. According to the preference of the operator, an inhalator mask may be applied before the stripping or after respirations have been induced. Injection into the cord substance or the umbilical arteries is of no avail. In rare cases injection may be difficult if the vein is small or collapsed. The latter condition is easily corrected by having the assistant compress the cord between the fingers at the umbilicus and slide them a short distance toward the clamp. This causes the vein to stand out clearly.

Identification of the umbilical vein. (1). The umbilical vein is more superficial and larger than either individual artery. (2) The umbilical vein nearly always discloses points of dilatation and varicosity, and this in conjunction with its greater size will identify it. Inject at an area of dilatation.

Figure 7 is a blood pressure tracing from the external carotid artery of the cat and is rep-

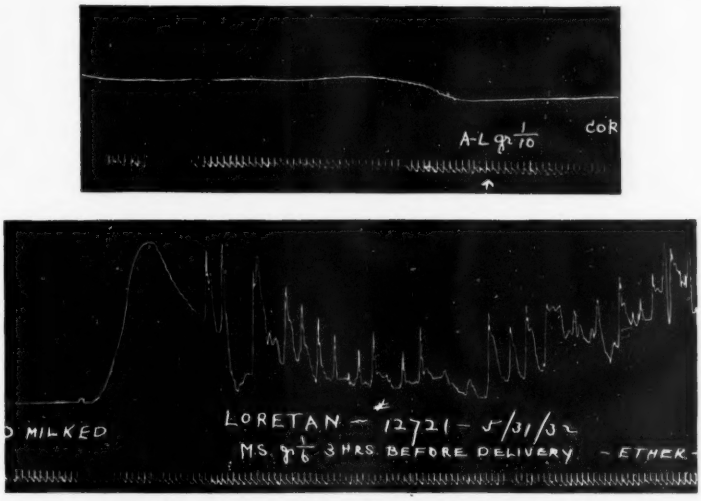

Fig. 13. E. L. No. 12721; weight, 8 pounds; gestation, 9 months; labor, 18 hours, 20 minutes. Three hours before delivery 1/6 grain morphine sulphate was given. No other medication was used. Delivery was spontaneous. Ether anesthesia was used. Baby was white, completely limp, and presented a picture of the most severe state of asphyxia pallida. Only slow and very weak cardiac pulsations could be detected. The cause of the asphyxia was undetermined. One and one-half minutes after delivery 1/10 grain lobeline hydrochloride was injected. Twenty-one seconds later the cord was rapidly and completely milked. Fifteen seconds thereafter a deep and powerful inspiration occurred. The tracing shows that following delivery no respiratory efforts were made. The amount injected was relatively large, and the respiratory muscles were thrown into a temporary fixation. Relaxation of these muscles followed and then respirations began. That the respiratory center had been severely depressed is indicated by the newly established respirations which are seen to be markedly irregular. The important point is that the baby is breathing which should be contrasted with the apnea before injection. Complete recovery followed.

The degree of asphyxia is shown by the following blood findings: oxygen content, 0.9 volumes per cent; pH, 7.01.

resentative of many others. A rather sharp rise followed by a slow fall, sometimes to a little below the base line with a gradual return to normal, has been a relatively constant finding. The blood pressure effects are not significant. Clinically there has been no evidence of either cardiac stimulation or depression. The question is of little importance because as soon as a few respirations have occurred, the oxygenation of the blood brings about an immediate improvement in the circulation. Figure 8 illustrates the effect of lobeline, administered for purposes of demonstration, on a normal, breathing baby. Figure 9 shows an excellent result on a morphinized infant. It is apparent at a glance that there is a tremendous expansion of the thorax with a consequent opening of innumerable alveoli. The flow of tidal air and gaseous interchange with the blood are therefore proportionately increased. Figure 10 is a graph taken for teaching purposes. It demonstrates a marked change in rate and amplitude and a corresponding increase in respiratory efficiency of about 310 per cent. Figure 11 illustrates a considerable expansion of the thorax. A change of respiratory style has been brought about. Breathing now takes place with the chest in an inspiratory position. Any atelectasis has been, at least partially, overcome.

The graphs have been presented solely to furnish pharmacological evidence. There is no intention to indicate that the treatment was necessary. On the other hand it would be difficult to deny that the babies in question were not better off as a result of the respira-

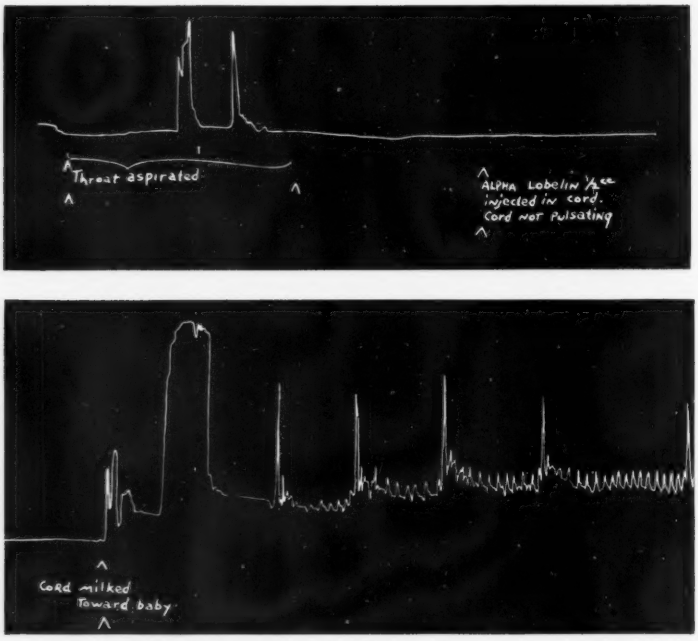

Fig. 14. A. F. No. 12535; weight, 6 pounds 13 ounces; gestation, 9 months; labor, 16 hours, 7 minutes. Two hours before delivery 1/8 grain morphine sulphate was given. Gas-oxygen ether anesthesia was used. Delivery was spontaneous. There was a tight knot in the cord. Baby was pale and flaccid. There were no pulsations of the cord. A slow and faint cardiac impulse was discernible. The condition was judged to be critical. One and three-quarter minutes after delivery 3/40 grain lobeline hydrochloride was injected. The cord was stripped 52 seconds later. This copy of an original graph shows a prolonged apnea. The two movements of the scribing point before injection should be disregarded. They were caused by pressure on the bag during aspiration. The apnea continued until milking, which resulted in a deep inspiration, maintained for 6 seconds. Then a series of inspirations at intervals of about 17 seconds, interspersed with shallow respirations, followed. The latter tended to increase in depth and rate. CO_2 7 per cent—O_2 93 per cent administered after removal of infant from pneumograph. Recovery. Oxygen content was 1.3 volumes per cent; pH, 7.06.

tory stimulation. Those graphs which illustrate the initiation of respiration (Figs. 12, 13, 14) are in a different category. The last two, particularly, in conjunction with the clinical picture and blood findings, indicate apneas of a serious nature. Although it is impossible to prove it, it is highly probable that the treatment saved their lives. In our experience the best results are obtained from centers depressed by morphine, chloral hydrate, and the barbiturates. In moribund babies only irregular gasps may follow injection, but these are sometimes adequate to save life. In serious but less profound asphyxias, vigorous and fairly regular respirations are initiated. The visible effects of the drug disappear in from 2 to 4 minutes.

Lobeline acts by lowering the threshold of the center to the carbon dioxide present in the blood. The first inspiration takes place within 15 seconds after milking the cord, if the center is not irreparably damaged. It is imperative that the drug be correctly administered. Before the respiratory response, there is a stiffening of the entire body frequently resulting in a mild opisthotonus. The inspiratory gasp follows almost immediately. These findings are so constant that if they are absent, it is almost conclusive evidence that the drug is not in the general circulation. The increase of

tonus is itself of great value. Certain writers have opposed the use of drugs because of the danger of overdosage. This is not a valid objection because, if it were, it would be necessary to discard in many diseases, remedies which are poisonous in excess. Overdosage with the hydrochloride does not result in depression, but only in a temporary apnea. This is due to a fixation of the chest and diaphragm in the inspiratory position as a result of excessive stimuli from the center (40). This apnea is in itself harmless except that the desired pulmonary ventilation does not occur. Since delay in pulmonary ventilation is injurious, the apnea for this reason is undesirable. It will not occur if the dosage is correct. The most satisfactory results are obtained with 1/20 grain, although 1/40 grain elicits an excellent response in mild cases. As high as 3/20 grain may be employed although with the larger amounts the aforementioned apnea may be encountered. In order to allay apprehension about overdosage, we may state that after careful tests on animals we have used in babies as much as six times the recommended dose without permanent ill effects.

In this institution up to January 1, 1937, lobeline hydrochloride has been injected into the circulation of 340 babies. A detailed analysis of these cases will be published in the future. It should be stated that many of the injections were administered to normal babies in order to secure additional data. All treated babies were subsequently observed by competent pediatricians. In no instance did side effects such as vomiting or convulsions ensue, and no infections of the umbilicus were noted.

Summary. Intravenous resuscitation appears to have only a limited field in the poorly breathing baby but is of great importance in the stillborn. Its rôle is almost exclusively that of initiation.

Two highly desirable aims, namely an increase of body tonus and a favorable influence on the respiratory center, have been satisfactorily achieved by lobeline hydrochloride, which has been found to be safe and free from side effects. Its use in combination with other drugs is, at present, under investigation.

Important advantages of this method are economy, simplicity, and rapidity of action. Disadvantages are the transient nature of the response and the necessity for perfect asepsis.

TECHNIQUE

The most important methods of resuscitation have been presented. It is apparent that no one of them is entirely satisfactory. We have found that in combination, however, most encouraging results may be obtained, and suggest the intravenous use of a respiratory stimulant in conjunction with tracheal insufflation and the subsequent application of an inhalator. The technique, important particularly in asphyxia pallida, is as follows:

Immediately after delivery as much material as possible is aspirated with a rubber catheter. The umbilical vein is then injected and stripped to just short of the half-way mark (Figs. 5 and 6). A second clamp is, however, applied here to prevent the blood from returning toward the site of injection. So far the initiating substance has not entered the circulation, but has been made ready for subsequent use. The next step consists of introducing a laryngoscope, the baby lying on a table with the head over the edge in hyperextension. Suction of the larynx and trachea is performed, using a hollow sound designed for this purpose, and the tracheal tube then inserted. The latter insufflates a mixture of carbon dioxide and oxygen in the proportion of 20 per cent to 80 per cent, respectively, under intermittent pressure (5 to 12 millimeters of mercury). If preferred, lesser percentages of carbon dioxide or pure oxygen may be used. The initiating drug is slowly milked into the circulation by further stripping of the cord, a sufficient amount being introduced to bring about a definite gasp and subsequent respirations. The carbon dioxide entering the newly opened alveoli results in an increase in depth and frequency of the respirations. The oxygen quickly improves the circulation and also renders the respiratory center more sensitive. When high percentages of carbon dioxide are used, the tube should be withdrawn in from 1 to 2 minutes after breathing has commenced (Cases 9 and 10, Table I), the tongue pulled forward by a clamp or suture, and an inhalator placed over the face. If the lower percentages or pure oxygen are favored, the tube may be left in place much longer. The inhalator supplies percentages of about 7 and 93, respectively. This treatment is continued until the child is out of immediate danger. In severe cases it is advisable to administer these gases at intervals for approximately 5 days.

In 2 cases which came under the care of one of us (R.A.W.) the babies showed no signs of life. Epinephrin was injected directly into the heart. As a result, some faint cardiac pulsa-

TABLE II—RESPIRATORY DEPRESSION OCCURRING IN 17,860 LIVE BIRTHS, INCLUDING 1,051 PREMATURES[1]

	Cases	Per Cent
Mild asphyxia	78	
Moderate asphyxia	215	
Severe asphyxia (including asphyxia pallida)	88	
Total number which did not breathe promptly at birth	381	2.13
Intravenous therapy (lobeline—alone or in combination) for the initiation or re-initiation of respiration—		
Mild asphyxia	23	
Moderate asphyxia	143	
Severe asphyxia (including asphyxia pallida)	68	
Total	234	
Failure to respond after injection or response followed by death within 2 weeks—		
Asphyxia and congenital malformation	2	
Asphyxia and hemorrhagic disease	1	
Asphyxia and cerebral hemorrhage	6	
Asphyxia	4	
Asphyxia, atelectasis and prematurity	10	
Total	23	9.82

Prematures of less than 28 weeks' gestation are omitted. Also all deadborn. The absence of visible or audible cardiac pulsations was the principal criterion in cases of doubt. The majority of doubtful cases received an injection of epinephrin directly into the heart. On rare occasions a response was obtained. The case was then treated and classified as a live-birth.

[1]These statistics compiled by Dr. Martin Z. Glynn.

tions were observed; the preceding technique initiated respirations, and both babies recovered. A number of cases have been reported in which life was saved by the intracardiac injection of epinephrin. If death is not absolutely certain, epinephrin should always be tried.

This combined technique embodies advantages of important methods with few of their disadvantages. The tracheal tube overcomes obstruction and, if gases are employed, brings them into the lungs under a safe pressure, ready to be absorbed at the first opening of alveoli. No attempt is made to dilate the alveoli forcibly within. The use of an inhalator, when respirations have been established, is an accepted procedure. It is not imperative to employ varying percentages of carbon dioxide, although some writers have claimed benefits from the brief use of a high concentration. This has been challenged (9). A 5 to 7 per cent strength is effective and when used, does not require the early removal of the tracheal tube. The technique is effective in any case sufficiently serious to have a diminished or absent laryngeal reflex.

The importance of thorough suction cannot be overestimated. The initial inspiration may otherwise result in inundating the bronchial tree with liquor amnii, blood, meconium, etc., and the baby drown or die of shock.

SUMMARY OF STUDY

From January 1, 1927 to January 1, 1937, during which time the greater part of this study was conducted, 17,860 live babies, from 7 to 9 months of gestation, were born in the Methodist Episcopal Hospital (Table II). Among them were many instances of respiratory depression and asphyxia ranging from mild morphinization to asphyxia pallida.

The 10 cases in Table I are examples of the latter class. In none were drugs administered to the mother less than 5 hours before delivery. In Case 4 no anesthetic was used. In the others gas-oxygen with and without the addition of ether was employed. It is our custom to use a minimum amount of ether; therefore the anesthetic played a minor part as an etiological factor. Unless otherwise specified the "Simple Measures of Resuscitation" included: suction, holding the baby head downward with the head extended, gentle flagellation, and sometimes pressure on the chest.

Delay in the employment of more modern methods in a few of the cases is explained by the reluctance of some obstetricians to utilize unfamiliar procedures when past experience has led them to believe older ones adequate. In Case 10 the armamentarium was not immediately available.

It is difficult, of course, to describe satisfactorily the relative severity of each case. Pallor, shock, and degree of tonus vary and can best be appreciated by those present. With the exception of Case 6 the cardiac pulsation is described. This is a useful index of the extent and duration of oxygen deprivation. The most accurate index of the gravity of a particular case is supplied by a blood analysis which was taken in all but Case 2. Other factors such as trauma, cerebral edema and hemorrhage cannot be estimated at the time of delivery. The oxygen content is normally about 12 volumes per cent, and it is remarkable that infants in Cases 3, 7, and 10 recovered. It is reasonable to assume that the low content persisted for only a short time, insufficient to damage permanently the delicate nerve cells of the center. On the other hand in Cases 7 and 10 the content must have sunk lower, for considerable time elapsed be-

tween taking the blood and the first inspiration. Considering 7.40 to be a normal hydrogen-ion concentration, some of the readings fell to very low levels hardly compatible with recovery.

The blood was obtained under oil immediately after delivery before any resuscitative action was taken. The cord was doubly clamped and cut about 8 inches from the baby, and the blood was then removed from the placental section of the umbilical vein. In Cases 7 and 10 the cord was clamped and cut before delivery. Oxygen content was determined according to the method of Van Slyke and Neill. The serum hydrogen-ion concentration was measured electrometrically. In many cases including several in Table I, the total carbon dioxide content of the blood was determined as well as an estimation of the carbon dioxide tension. These figures are not given as we believe the oxygen content the factor of prime importance. We wish to avoid any discussion of the relative merits of pure oxygen and carbon dioxide-oxygen mixtures in primary resuscitation. A moving picture film was made of Cases 1 and 5 and this film, which includes the resuscitation of other cases, is available for those who are interested.

The question has been raised whether or not intravenous resuscitation should be practiced alone, if gas therapy or at least a tracheal tube are not available. This is optional when the prognosis appears favorable, even though the depression is deep and the respirations for the time being inadequate. Inasmuch as the graphs show that respiratory efficiency can be increased, and the thoracic cavity expanded by this method, it would seem that there is something to be gained and nothing to be lost by its use. The answer is decidedly in the affirmative if a prolonged apnea which has not responded to simple measures must be treated. This procedure will often initiate respiratory movements which, even if irregular, and comparatively few in number, result in air entering the alveoli. Although this fulfills only part of our recommendation, it is superior to crude, older methods.

Unless each stage of a technique has been previously experienced, success will not necessarily attend the first use of modern methods in an urgent case. Adeptness at identifying, injecting, and stripping the umbilical vein is gained by injecting saline into normal infants. It has been observed that a primary failure will often severely prejudice one against later attempts, even when the technique was faulty.

We sincerely feel that a consideration of this study by those with open minds will result in the saving of many lives which would otherwise be lost.

CONCLUSIONS

1. The treatment of asphyxia neonatorum has not kept pace with other advances in obstetrics. Methods sometimes dangerous and of doubtful efficacy are widely employed. A thorough understanding of drugs, anesthetics and resuscitation should be part of the knowledge of the obstetrician.

2. Less than 5 volumes per cent of oxygen in umbilical vein blood is accompanied by clinical evidence of asphyxia. It is shown that a brief fall below 1 volume per cent is not necessarily fatal, but longer exposures cause permanent damage to the delicate nerve cells of the center and resuscitation is no longer possible.

3. New evidence is brought to light indicating that the atelectatic lung cannot be opened by gases under pressure in the trachea. Pressures as high as 18 millimeters of mercury fail to open alveoli and result in damage to the lung tissue. Lower, and therefore safer, pressures are even less efficacious.

4. Respiratory depressant drugs and anesthetics are discussed and listed in the order of their safety. Morphine alone or in combination, in the opinion of many, has other purposes during labor besides the relief of pain. Because of this, it need not be abandoned, as has been suggested by some writers, but should be expertly administered not less than 2 hours before delivery.

5. Methods of resuscitation both old and new are analyzed, and it is shown that no one method is entirely satisfactory.

6. A new method for obtaining graphs of the apnea and early respirations of the newborn is briefly described. The method furnishes conclusive evidence of respiratory status at birth, the effects of drugs and

anesthetics administered to the mother before delivery, upon the baby, and shows the efficacy of various methods of resuscitation.

7. The results of animal and clinical studies of analeptics and respiratory stimulants are reported. Lobeline hydrochloride has given satisfactory results, particularly in regard to safety.

8. It is shown that in cases of asphyxia pallida, the injection of a respiratory stimulant is logical and to a large extent the only possible way of producing a respiratory gasp.

9. An improved technique for the administration of respiratory and cardiac stimulants, saline, etc., by means of the umbilical vein is described.

10. We suggest and describe a technique which combines 3 methods for the treatment of serious cases. By this means important requisites are fulfilled and excellent results obtained.

The authors extend their acknowledgment and thanks to Dr. O. P. Humpstone, director of the department of obstetrics and gynecology, the Methodist Episcopal Hospital, for the privilege of undertaking this study; to Dr. Ralph M. Beach for numerous suggestions, and to Miss Mabel R. Duryea, R.N., for her invaluable co-operation.

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PERITONEOSCOPY

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PERITONEOSCOPY is the procedure of visualizing the peritoneal cavity and its contents by means of an optical instrument. The first demonstration and application of this procedure was successfully carried out over 35 years ago and yet, strange to say, the method is but little used. In part, the reason for this reluctance to apply it is seen in the traditional wholesome conservatism with which every new scientific thought contends, and yet the endoscopic method of examining body cavities has hardly met with a clinical mishap which could serve as a hindrance to its acceptance.

Any procedure that allows one to see, through a mere puncture, the diseased organs clearly and sharply in the peritoneal cavity, without a laparotomy and without discomfort to the patient, is ideal. It is especially ideal when a biopsy from tumors or tissues may be obtained, after recognition of the pathology. The procedure of peritoneoscopy offers such an alternative. This method, however, will not and cannot replace a laparotomy, but it is the procedure of choice in a great many abdominal conditions. An acute abdominal case should not be considered, or selected for peritoneoscopy. Chronic cases only should be used, and hasty surgery should be censured when there is plenty of time to make a diagnosis on chronic abdominal conditions.

The internist must share the responsibility for fruitless laparotomies performed for diagnostic purposes; and should use all the ancillary procedures at his disposal before he recommends a diagnostic laparotomy, in order to make or corroborate an intra-abdominal diagnosis. Unfortunately, many of the diagnostic methods that are in use today for making intra-abdominal diagnoses allow only vague and presumptive conclusions. It is true that, by means of x-ray, a diagnosis may be made of intragastric lesions or lesions that affect the continuity and contour of the gastrointestinal tract.

The roentgenologist can say whether a tumor is extragastric or intragastric, and in many cases, he can indicate the probability whether the lesion is malignant or not.

The gynecologist is able to palpate tumor masses in the pelvis, and, by correlation with clinical history and symptoms, he makes a presumptive diagnosis of the pathology encountered.

In cases of ascites, the internist, by correlation of the findings, and the examination of the fluid, will make a presumptive diagnosis of cirrhosis, malignancy, or tuberculosis, etc. Tumor masses are often encountered in the abdominal cavity, and the question arises as to whether these are cysts, abnormal lobes of the liver, retroperitoneal tumors, or malignancies. A diagnostic laparotomy, often referred to as a mere trifle, may be from the patient's point of view, a very formidable affair. It usually involves a general anesthetic followed, probably, by some flatulent discomfort, some anesthetic vomiting, 2 or 3 weeks' rest in bed, and occasionally complications with the wound. The expense may be considerable. In cases of carcinoma of the stomach or malignancy of the pancreas, death may follow so soon after as to raise a suspicion that the operation had something to do with the termination of the case.

Exploratory laparotomy	Peritoneoscopy
1. Economic features—large	1. Economic features—small
a. Major operation	a. Minor operation
b. Hospitalization—2 weeks	b. Hospitalization—1 day
c. Dressings—many	c. Dressings—few
2. General anesthetic	2. Local anesthetic
3. Diet limitations	3. No diet restrictions
4. Discomfort variable	4. Practically no discomfort
5. Large incision	5. ¼ inch incision
6. Mortality risk—6 per cent (Lahey)	6. Mortality risk—0.2 per cent

Diagnostic laparotomy is often harmful by the accentuation of a neurosis and the ex-

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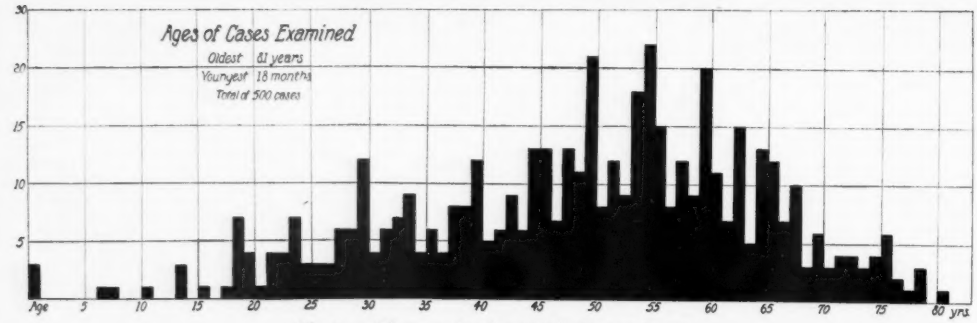


Chart 1. Diagram showing distribution as to age.

acerbation of symptoms, because of an undiscovered lesion, or an inoperable lesion. A diagnostic laparotomy becomes fruitless in those cases in which intra-abdominal malignancy of an inoperable nature is suspected and a laparotomy is done in the hope that the presumption is not correct. Peritoneoscopy is a far less formidable alternative.

The procedure of peritoneoscopy has been carried out, for diagnostic purposes, on over 500 cases (Table I), the majority of the patients have been referred from the general diagnostic service of a large general hospital and others from private physicians. These patients have ranged in age from 18 months to 81 years, and have been both males and females (Chart 1). Many of the cases have been complicated with ascites so that a diagnosis has not been possible medically. Patients have been followed to the operating table whenever possible, and at postmortem—while many patients are still living.

TABLE I.—ANALYSIS OF 500 CASES EXAMINED

Purpose of examination	Cases
Differential diagnosis	308
Corroborating diagnosis	118
Determination of metastases	58
Differentiation and localization of tumors	16
Total	500
Types of cases	
Males	215
Females	285
With ascites	229
With jaundice	100
Biopsy specimens from organs and tumors	39
Follow-up	
Autopsies obtained	63
Subsequent operations	231

ANALYSIS OF 500 CASES EXAMINED

This series of 500 cases includes all cases examined or attempted in succession, over a period of 4 years, and cases are not selected. A successful method of obtaining biopsies was not accomplished until after 300 of these cases had been examined. Biopsies are taken only in selected cases. Chronic pelvic inflammatory diseases, ectopic pregnancies, or negative abdomens do not require biopsies. The determination that a tumor mass is an accessory lobe of the liver, a spleen, or a mass of rolled up omentum does not require a biopsy. Biopsies are taken when the abdominal pathology encountered is not obvious.

Biopsy material has been obtained from growths in the peritoneal cavity, when indicated for diagnosis. Biopsies have been taken repeatedly from the liver. All ascitic fluid obtained is given a careful examination. This is done by centrifuging, embedding the sediment in paraffin, sectioning and then examining and classifying the cytology present. Many cases of malignancy have been proven by this method. In addition, a bacteriological examination is made in every case.

The following pathological conditions have been noted, and diagnosed: general carcinomatosis of the peritoneal cavity; carcinomatous nodules in the liver (Fig. 1); carcinoma of the gall bladder; melanotic sarcoma of liver with metastases to the peritoneum; hemangioma of the liver; hydrops of the gall bladder; lymphoma of the stomach, carcinoma of the stomach; fibroid tumor of the uterus (Fig. 2); normal pregnancy; ectopic pregnancy (ruptured); ovarian cyst

(Fig. 3); ruptured chocolate cyst of the ovary; papillary cystadenoma of the ovary with metastases (Fig. 4); hydrosalpinx; retroperitoneal myxosarcoma; retroperitoneal sarcoma; lipomyxosarcoma; cirrhosis of the liver; passive congestion of the liver; hepar lobatum; pancreatic cyst; carcinoma of the colon; intra-abdominal hemorrhage; intra-abdominal adhesions (Fig. 5); tuberculous peritonitis; calcified lymph glands; retrocecal appendix; polycystic kidney.

Patients with ascites offer the best type of case for this procedure because the abdominal wall, which has been stretched by the fluid, when withdrawn, allows the easy introduction of air. It is surprising how little discomfort is noted following the introduction of air into the peritoneal cavity, even in those cases in which there has been no previous distention. Ordinary atmospheric air is used instead of oxygen, nitrogen, or carbon dioxide. The amount of air introduced is not important as long as the patient is flat or in the Trendelenburg position. In my series there have been no complaints of the usual shoulder pains often described following a tubal insufflation. The air is always removed following the procedure, although some residual air, localized between the liver and diaphragm, often remains. This has been noted occasionally in cases examined with x-ray shortly following the procedure.

THE VALUE OF THIS METHOD

The value of peritoneoscopy lies in its ease of application and the differential diagnostic possibilities obtained through this direct, eye controlled method of examination. It is possible to diagnose a questionable case correctly and without delay. It is possible to decide early the advisability of operation in patients showing grave pathology. It is possible to differentiate tumor masses from various organs in the peritoneal cavity. It is a simple method for determining the operability of malignant gastric lesions.

Because of its ease of application, it is the method of choice, in preference to a diagnostic laparotomy for the differential diagnosis in cases of undetermined ascites, tuberculous peritonitis, the source of tumors, the operability of intra-abdominal lesions, and the question of intra-abdominal metastases.

The indication for its use in gynecological cases needs no comment when the profession realizes the extent to which this ideal method of examination of the pelvic organs can be carried out. We are able to see the organs clearly in their natural living colors.

Peritoneoscopy does not, and will not, replace laparotomy; but it is the procedure to be selected when confronted with the above diagnostic problems.

I find several instances in my series where the clinical diagnosis appeared self-evident, but which was altered by peritoneoscopic examination. This has been true principally in cases in which the diagnosis has been changed from cirrhosis to malignancy or from malignancy to cirrhosis.

It is my opinion that all patients with clinical cirrhosis of the liver, or suspected cirrhosis, should have the benefit of a peritoneoscopy, in order definitely to classify the condition.

HISTORY OF THE SUBJECT

In 1901, Kelling (11, 12) first demonstrated this procedure on a living dog by inflating the abdominal cavity with air and examining the contents with a Nitze cystoscope. Kelling later published two monographs in the German literature, the first appearing in 1902 and the second, dealing with human subjects, in 1910. In 1910, Jacobaeus (3–9) of Stockholm published a paper on a like procedure of visceral exploration, developed independently by him.

In 1923, after 13 years of silence, Kelling (13) addressed the German surgical society concerning this subject. He related how the bad economic situation of the population after the war had compelled him to make wider use of this diagnostic method among his patients, since it saved them the prolonged and costly stay in the hospital which an exploratory laparotomy entails. The work of Kelling becomes remarkable in that the technique applied and described by him 35 years ago is, with little modification, the technique used today. He made use of pneumoperitoneum long before it was practiced in the field of

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 1. Carcinoma metastases in liver. Note the metastatic implantation on under side of diaphragm. View as obtained through peritoneoscope.

Fig. 2. Fibromyoma of uterus viewed through peritoneoscope.

Fig. 3. Ovarian cyst viewed through peritoneoscope.

Fig. 4. Papillary cystadenoma of ovary with peritoneal implantations viewed through peritoneoscope.

Fig. 5. Intra-abdominal adhesions. Note how adhesions between omentum and parietal peritoneum are stretched by the production of pneumoperitoneum. Viewed through peritoneoscope.

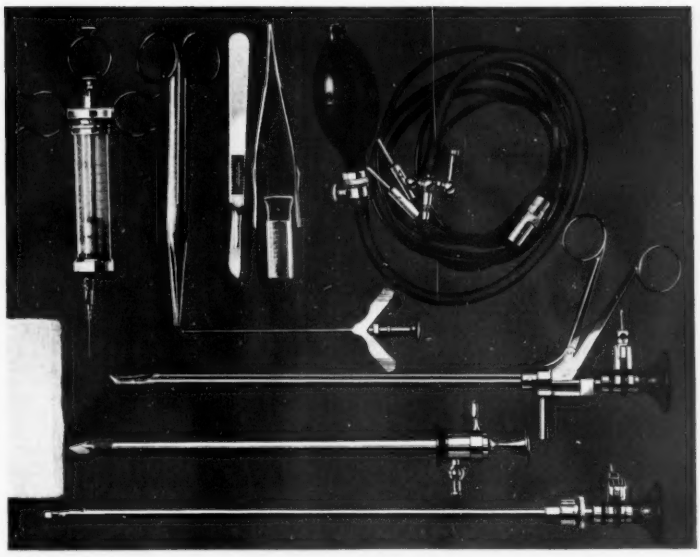


Fig. 6. Instruments necessary for procedure arranged with accessories: telescope, sheath with bistoury tipped obturator, biopsy forceps with telescope, pneumoperitoneum needle, sphygmomanometer bulb and tubing, electric cord connection, scalpel, scissors, thumb forceps, syringe, sponges, and skin clamps.

roentgen diagnosis, but he failed to make early clinical application of his method and let Jacobaeus of Stockholm, almost 10 years later, receive recognition for the procedure. Kelling maintained that the mobility of the intestines in the living subject is such that they will not sustain injury, but will recede or slip aside before the gentle and slow thrust of the trocar. This same fact was brought out by Jacobaeus in his monographs on the procedure. Jacobaeus later devoted his major interests to the perfection of thoracoscopy and developed the technique of galvanocautery for separation of adhesion bands in the chest preliminary to collapse of the lung as used today throughout the world.

In 1911, Bernheim, an American, working at Johns Hopkins Medical School introduced a proctoscope of ½ inch bore through an incision in the epigastrium and with the aid of a head mirror examined the stomach, liver, gall bladder, and diaphragm.

In 1912, Nordentoeft, of Copenhagen, devised an instrument which he termed a "trocar-endoscope" and patented under that name. He described the first views of the interior of the female pelvis as seen when the patient was in Trendelenburg's position, after the abdomen had been distended with air.

In 1912, Tedesko, of Vienna, reported his experiences with laparoscopy, following the technique described by Jacobaeus.

In 1912 and 1919, Stolkind, in Russia, reported the use of this procedure.

In 1913, Meirelles, in South America, published a discussion on laparoscopy.

In 1913 and 1915, Renon and Rosenthal, of Paris, considered this method excellent for making visible to the observer certain affections of the liver and peritoneum.

In 1914 and 1920, Roccavilla, of Italy, modified the method by designing an instrument which permitted the source of light to remain outside the abdomen.

In 1920, Orndoff, of Chicago, stated that he experimented with this method many years and was still practicing it. He particularly praised it in diagnoses of hemoperitoneum, tuberculous peritonitis, and extra-uterine pregnancy.

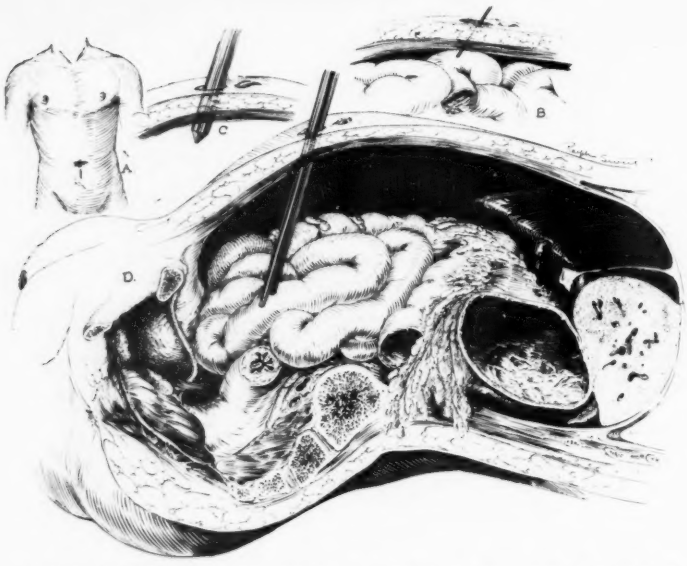


Fig. 7. Technique of peritoneoscopy. A, Usual site of puncture; B, insertion of pneumoperitoneum needle; C, insertion of trocar; D, visualization of peritoneal contents with peritoneoscope.

In 1924, papers appeared from Edwards, of London; Steiner of Atlanta, Georgia; Stone, of Kansas; Zollikofer, of Switzerland; and Unverricht, of Germany.

In 1925, Nadeau and Kampmeier, of Chicago, published a very complete description of the technique of endoscopy of the abdomen.

The procedure has been given various names by the various workers who have pioneered in its development.

1. Cœlioscopy (Kelling, 1901)
2. Ventroscopy (Van Ott, 1901)
3. Laparoscopy (Jacobaeus, 1911)
4. Organoscopy (Bernheim, 1911)
5. Peritoneoscopy (Orndoff, 1920)
6. Abdominoscopy (*Medical Dictionary*, and Steiner, 1924)
7. Celoscopy (*Medical Dictionary*)
8. Splanchnoscopy (*Medical Dictionary*).

The peritoneoscope (Fig. 6) developed for the examination of this series consists of five parts: (1) sheath, (2) bistoury tipped obturator which fits the sheath, (3) telescope made to fit the sheath, and a biopsy forceps, (4) fluid evacuator, (5) small needle trocar for pneumoperitoneum and a special Rehfuss tube with an electric light at the tip.

The sheath is of metal, lined with bakelite, the top of which is fitted with a lock and with a stopcock on the side. The sheath is arranged to receive snugly and lock in place the bistoury tipped obturator, with dull point. When the obturator is in place the instrument becomes a trocar for making a puncture in the abdominal wall.

The telescope is one which gives the highest degree of light, the largest field, the smallest magnification, and the most direct vision. It is necessary that the telescope fit the sheath with an air tight connection. It should be long enough to reach every part of the abdomen through one puncture below the umbilicus.

The biopsy forceps is a special rongeur tipped forceps for securing specimens through the sheath. It fits the sheath air tight. A special telescope allows visualization during the procedure of taking the biopsy. An electrical connection on the forceps allows the use of a coagulating current to control bleeding. The tip of the biopsy forceps becomes the coagulating electrode after specimen is taken.

The fluid evacuator is a straight tube closed at one end with multiple small perforations in its distal half. It is also equipped with an air tight lock that allows it to fit in the sheath. The open end is connected with a suction apparatus. The tube can be slipped in and out of the sheath which allows it to be pushed among the coils of bowels without injury.

Rubber tubing is necessary to connect either the fluid evacuator to a suction apparatus for withdrawing the fluid or to connect a bulb similar to that used on a blood pressure apparatus with the stopcock on the side of the sheath to inject air.

The pneumoperitoneum needle is a small, dull trocar needle apparatus 5 inches long. At the hilt of the needle there are two flanged handles so that it may be held steady during the inflation of air. The bulb with rubber tubing is arranged to fit this needle.

The stomach tube has an electric light on the tip and a perforation just proximal to the tip. Wires are threaded through the tube for the electrical connection. The electrical connection is similar to that used on the telescope, and is combined with an air connection which allows the stomach to be inflated with air at the time the light connection is made.

The procedure of peritoneoscopy has been done in all cases in the operating room. Strict aseptic technique has been used throughout the procedure.

The operating room technique is the same as for a laparotomy. The patient is draped and the abdomen prepared as for an abdominal incision. The peritoneoscopic instruments are sterilized by emersion in 1:1000 mercury cyanide solution for 30 minutes. This includes the electric cord for lighting purposes. Alcohol cannot be used as a sterilizing agent for the telescopes because it dissolves the cement around the lenses.

The equipment for an operating room set-up is as follows:

1. One 20 cubic centimeter Luer syringe with needles for anesthetization.
2. 30 cubic centimeters of 1 per cent novocain solution.
3. One scalpel.
4. One dozen small gauze sponges.
5. One baumamometer bulb.
6. One 8 inch or one 12 inch piece of rubber tubing to fit bulb and air connection of sheath.
7. One battery for lighting instruments.

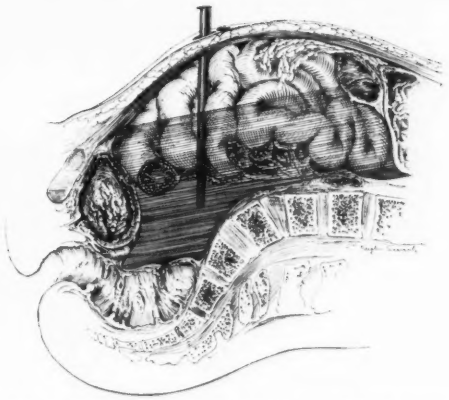


Fig. 8. Removing ascitic fluid with special fluid evacuator with patient in horizontal position.

The operating room should be so arranged that it may be made dark during the examination.

TECHNIQUE

No preparation is necessary before the examination other than ¼ grain of morphine about 20 minutes before the puncture is to be made. The site of puncture is selected and local anesthesia with novocain is used. It is a good plan to encircle the puncture site with subcutaneous wheals of novocain with a diameter of approximately 10 centimeters. Following this, the needle is inserted to the peritoneum, and novocain is infiltrated just above it. A small stab incision is made just large enough to admit the sheath of the instrument snugly, and the point of the knife is carried down until the fascial layers are nicked. The pneumoperitoneum needle is inserted into the abdominal cavity gently and moved around in a circle to determine the presence of adhesions or fixed bowel at the point of entry. The abdomen is then distended with air and the pneumoperitoneum needle is removed. The sheath with the bistoury tipped obturator, which acts as a trocar, is now inserted into the abdominal cavity. When ascitic fluid is present, the insertion is exactly the same as the insertion of a trocar preparatory to an abdominal paracentesis. It is necessary in all cases that the abdominal wall be tense and fixed, either by distention of abdominal cavity with fluid or air, or both. The

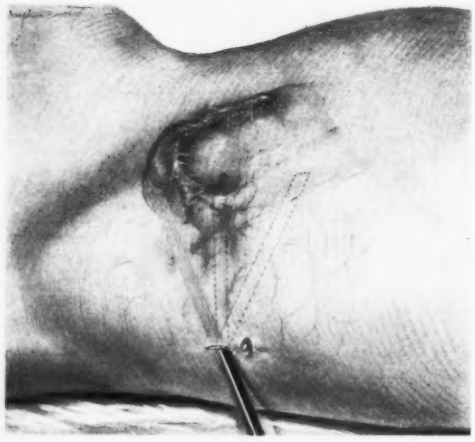


Fig. 9. Visualization of appendix (retrocecal) with patient on left side. Air displaces cecum so that appendix may be visualized.

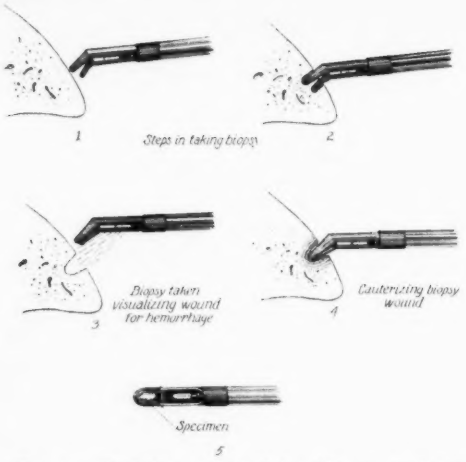


Fig. 10. Technique of obtaining biopsy specimens through the peritoneoscope.

puncture must be carried out steadily and cautiously with the instrument pointing to either side of the spinal column, so that if the entrance into the cavity is made suddenly the gut will not be injured against the bony column.

As soon as the entrance has been accomplished the obturator is removed and the telescope is inserted. If fluid is present suction is applied with special evacuator inserted in the sheath and the abdomen emptied (Fig. 8). This is done entirely with closed drainage. After evacuation of the cavity the air bulb is connected and the abdomen is distended with air. Ordinary atmospheric air is used. It is not necessary to measure the quantity of air used, as the abdominal cavity is not sensitive to inflation, and the patients do not complain of any other sensation except one of fullness.

As soon as the abdomen is distended, the peritoneal cavity and its contents become visible, and the examination may proceed. Upon completion of the examination the air is allowed to escape. One may assist the evacuation of air by pressure with the hand placed flat on the belly. Having evacuated the air, the instrument is removed. In cases of ascites the ascitic fluid may drain for a day or two. In cases without ascitic fluid one skin stitch or skin clamp is used and a simple dressing is applied. No disability follows, and the patient is allowed to eat his meals without interruption.

VISUAL EXAMINATION

As the air is of light specific gravity, it remains uppermost in the abdominal cavity. Therefore, through changes of position of the patient, one is able to shift the air and thus displace the intestines at will. With the patient in a horizontal position, one has a full view of all organs in their normal relation under the abdominal wall. For an examination of the pelvis Trendelenburg's position is used. The organs in the left side of the abdomen come into view when the left side is uppermost, and likewise on the right (Fig. 9). Therefore, a safe and easily changeable table is needed for the examination. Movements of the instruments cause the patient no discomfort unless pressure is made against the parietal peritoneum, or a loop of bowel is pulled by the tip. The light of the instrument shines through the abdominal wall, when the room is darkened, and shows where the tip of the instrument is located. With one hand on the abdominal surface, pressure and manipulation may assist considerably.

The whole examination should be done with a fixed plan in mind, otherwise the wonderful

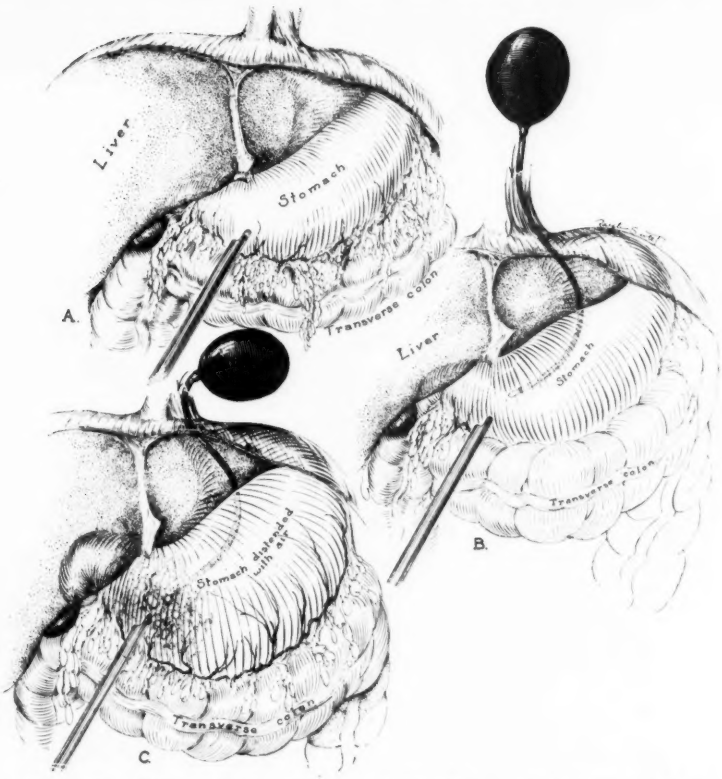


Fig. 11. Operability of gastric malignancy. A, Visualizing stomach, liver, and adjacent tissues and localizing malignancy; B, unfolding stomach under vision with air; C, transillumination of inflated stomach.

natural pictures would tend to lead astray and thus prevent seeing the important points. A general complete examination of the abdominal cavity, with recognition of organs and landmarks should be done before any diseased organs are examined. This is necessary in order that the examiner may become oriented and able to recognize the objects he sees. Pathological pictures may then be examined minutely. After a few examinations the pictures become very clear, natural, and easily understood. The instrument should be long enough so that a single puncture performed in the midline just below the umbilicus brings all the contents of the abdominal cavity into view. Puncture, however, may be made at any point in the abdomen.

Peritoneoscopy visualizes the surface of organs which are contained in the peritoneal cavity, but nothing inside of a viscus or buried deep in the tissues can be seen.

The liver, after air insufflation, falls away from the diaphragm and can be examined in regard to its color, smoothness, nodules and size. The edges can be followed, the upper surface, right and left lobes, and a portion of the under surface seen. The gall bladder can be noted beneath the edge. The thickness of the gall bladder, its color, circulation, and adhesions are easily seen. I have not been able to palpate the gall bladder with tip of the instrument for stones, as noted by Steiner.

The greater curvature of the stomach can be noted and the anterior surface examined.

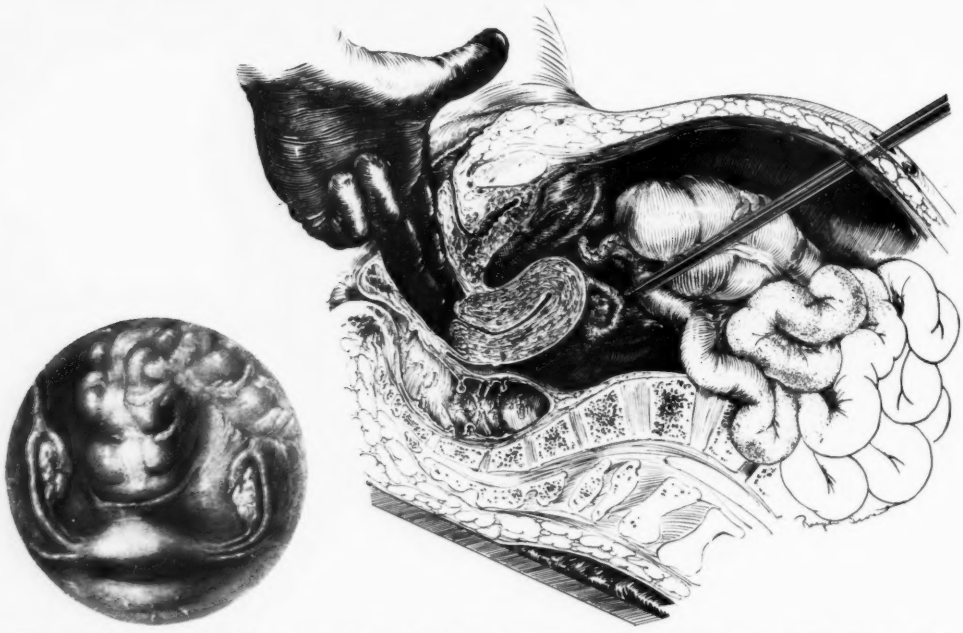


Fig. 12. Technique of pelvic examinations with view of pelvic organs obtained through peritoneoscope after pneumoperitoneum is produced. The diagram shows manipulation of pelvic organs through the vagina.

The lower tip and edge of the spleen is seen in the extreme upper left quadrant just beyond the stomach surface. When enlarged, the spleen is easily examined. The omentum can be examined completely. The surface of small coiled intestines gives a remarkable picture. Normally, they appear with a slightly brownish hue, and peristaltic waves can be noted. The surface of the cecum, the ascending, transverse and descending colons are easily visualized. The appendix is seen only occasionally.

The dome and posterior surface of the bladder, the fundus of the uterus, tubes, and ovaries are seen, and the pathological state noted. The parietal pelvic peritoneum can be examined completely throughout.

TECHNIQUE OF OBTAINING BIOPSY SPECIMENS

Biopsy specimens may be obtained through the peritoneoscope sheath (Fig. 10). Biopsy specimens should not be taken directly from the tissues of a hollow viscus, abscesses, or cysts encountered because of the possibility of injury or perforation. Liver and spleen biopsy specimens or suitable pieces of tissue from any solid organ or tumor mass can be obtained for examination. Biopsy specimens are easily obtained from metastases in the liver and omentum, or from the peritoneal surfaces.

The tip of the biopsy forceps when closed is so arranged that it forms a cup containing the tissue material. The closed tip acts as an electrode for coagulating the wound resulting from cutting the biopsy specimen. The biopsy material is not affected by the coagulation current. All wounds should be thoroughly coagulated after the specimen is obtained, regardless of whether bleeding is noted or not. This is especially true when the specimens are taken from the liver or spleen.

The abdomen should be completely distended with air and the point selected for taking the material should be isolated from adjacent tissues, so that there is no possibility of coagulating other than the point from which

the tissue is taken. Practically any type of high frequency generator, diathermy machine, coagulating unit or whatever else it may be called, can be used with the biopsy forceps for hemostasis or coagulation. The current may be properly adjusted before use, by trying it on a piece of meat.

A small visualizing telescope is used with the biopsy forceps so that the entire procedure of cutting the specimen and hemostasis is constantly under vision.

RECOGNITION OF PATHOLOGY

The macroscopic appearance of living tissues is quite distinctive and differs considerably from their appearance in the cadaver. Peristalsis is noted in intestines and stomach and pulsation is seen in liver and spleen.

When an examination is made of the contents of the abdominal cavity all the facts noted are correlated into a final conclusion. A large smooth, red liver would suggest chronic passive congestion or hepatitis; whereas a small liver with a wrinkled surface and hobnailed irregularities would suggest atrophic cirrhosis. Adhesions are noted as to whether they are situated at site of former operations, or are general. They may be spider web, lacelike, or massive bands. Carcinomatosis of the peritoneal cavity is seldom, if ever, associated with adhesions.

Absence of peristalsis in a localized area of the stomach suggests an intrinsic lesion in this portion. When the spleen is visible, it is enlarged. Dilated veins in the mesentery, stomach, and under surface of the diaphragm are seen in cases of cirrhosis. Malignant metastases usually are distinctive in that they are various sized nodules, but often miliary implantations are impossible to differentiate from miliary tuberculosis without a biopsy. A deeply jaundiced patient with a thickened, small whitish gall bladder would suggest chronic cholecystitis with stones, whereas a distended normal appearing gall bladder would suggest carcinoma of the head of the pancreas.

OPERABILITY OF GASTRIC MALIGNANCY

Early diagnosis is essential if there is any hope of reducing the mortality of stomach cancer from its present high rate. By the time the patient presents a classic picture of gastric malignancy, weight loss, emaciation, and vomiting, not much hope is left; though the lesion be technically removable, operative mortality then looms too high. In Lahey, Swinton and Peelen's series, the x-ray pictures proved diagnostically accurate in 95 per cent of the cases. However, these men concluded that the decision as to the operability of a given stomach cancer is difficult and easily mistaken. They concluded that palliative operations were distinctly unfortunate in these cases, but that exploration to settle the question of operability was frequently indicated and that the mortality rate in those exploratory laparotomies was low. In the Lahey, Swinton and Peelen series, only 25 per cent of the cases were operable. In their series, explorations were done on 17.4 per cent of inoperable cases with a 6 per cent mortality from the exploration.

In cases of given stomach cancer, three things are necessary as to the decision of operability, provided that no metastases are demonstrable in the skin, glands, lungs, or bones. These are:

1. Are there metastases in the liver?
2. Is there extension to adjacent tissue and peritoneum?
3. How much of the stomach is not involved?

These questions can be answered in a very high percentage of cases by means of peritoneoscopy. Visible metastases can be seen and easily identified in the liver. The peritoneal surfaces and omentum can be examined for visible metastatic lesions. The malignancy in the stomach can be seen and adjacent tissues examined for extension of the lesion. By means of air and transillumination, the amount of uninvolved stomach wall can be approximately estimated.

Peritoneoscopy should always be done in lieu of exploration in order to determine the question of operability of a stomach cancer. In the Lahey, Swinton, and Peelen series in which 17.4 per cent had explorations and were found to be inoperable, the majority of these cases could have been determined by means of the simple procedure of peritoneoscopy.

The operative mortality of 6 per cent could have been markedly lessened.

The technique (Fig. 11) for the examination of a known case of gastric malignancy is not difficult. The patient is prepared as described for peritoneoscopy. The stomach is clean and empty. The special stomach tube, fitted with an electric light at its tip, is placed in the stomach through the mouth prior to examination. The peritoneoscope is inserted as previously described. The liver is visualized for metastatic lesions; the stomach is examined in its normal state, noting circulation, color, and pathology visible. The stomach is now distended with air under vision and examined while it unfolds. Good stomach wall distends, infiltrated stomach wall is rigid. When the stomach has been distended with air, the globe at the tip of the tube is lighted and the stomach wall is transilluminated. The stomach appears to the observer like a "Chinese lantern" and any infiltrations in the gastric mucosa can be outlined. It has been my custom to have the surgeon present at this examination in order to determine with the peritoneoscopist the operability of the case. In a small percentage of cases of this kind, no metastases are found except in retroperitoneal nodes. If such is the case, an exploratory laparotomy must be done, as peritoneoscopy will not visualize these retroperitoneal glands.

PELVIC EXAMINATIONS

The gynecologist becomes very adept in determining lesions in the female pelvis bimanually. However, he is often at a loss to determine the source and type of tumor masses, the presence or absence of ectopic pregnancies, the congenital absence of organs and to differentiate at times chronic pelvic inflammatory lesions from other pathology.

When a patient is placed in the Trendelenburg position and a pneumoperitoneum is produced (Fig. 12), the viscera in the pelvis are displaced and the entire pelvis is exposed to view. The uterus, both tubes, both ovaries, and the sigmoid colon and bladder can be visualized. The examination is facilitated and assisted by inserting one hand in the vagina and manipulating the pelvic organs. The uterus may swing from side to side thus exposing the tubes, ovaries, and round ligaments. Occasionally one may push up into view tumor masses buried deeply in the broad ligaments.

Ectopic pregnancies, malignancy of the ovaries, engorged reddened tortuous tubes, hydrops of the tubes, absence of organs, malformations of organs, adhesions, pelvic tuberculosis, malignant metastases, malignancies of the ovaries, cysts, and fibroids can all be seen and recognized.

OTHER EXAMINATIONS

The sigmoid colon can be examined with the peritoneoscope in the same manner as a stomach examination is conducted. A tube may be inserted into the rectum on the tip of which is an electric light. The colon is distended with air and transilluminated.

This procedure is also applicable to examining the colon for spasm and spasticity.

Diverticula may be noted, and in one case a diverticulum of a bladder was seen.

Hernias may be visualized from inside the abdominal cavity, and the tip of the telescope may even be placed in the hernial ring.

Abdominal examinations may be markedly assisted by manipulation of tumor masses and viscera with one hand of the operator on the abdominal wall.

COMPLICATIONS AND ACCIDENTS

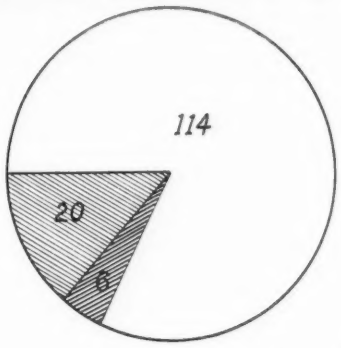
Puncture of a viscus is a complication that may happen to anyone attempting peritoneoscopy. This can be avoided, however, by: (1) careful examination of the patient prior to attempting procedure; (2) selecting the point of puncture to avoid all operative abdominal scars; (3) always using a bistoury plunger with a dull tip.

Kelling (11, 12) maintained in his early writings on this subject that the mobility of the intestines in the living subject is such that they will not sustain injury but will recede or slip aside before the gentle and slow thrust of the trocar. This same fact has been brought out by Jacobaeus (3–9), Ruddock, and other writers on this subject. It is my opinion that any viscus, unless so adherent that all freedom of movement is gone, will slip aside before the thrust of the trocar in the living subject. The

TABLE II.—ACCIDENTS AND COMPLICATIONS

Accidents	Cases	Per cent
1. Small bowel punctured with hypodermic needle, no sequelæ	1	
2. Small bowel punctured with pneumoperitoneum needle. Operation—hole repaired. Uneventful recovery. Cause—postoperative adhesions	1	
3. Small bowel punctured with trocar. Operation—hole repaired. Uneventful recovery. Cause—postoperative adhesions	1	
4. Small bowel punctured with trocar. Operation—hole repaired. Uneventful recovery. Cause—tuberculous peritonitis	1	
5. Transverse colon punctured with trocar. Operation—hole repaired. Uneventful recovery. Cause—carcinomatosis	1	
6. Sigmoid colon punctured with trocar. Operation—hole repaired. Uneventful recovery. Cause—intestinal obstruction (carcinoma of rectum)	1	
7. Stomach punctured with pneumoperitoneum needle. Operation—hole repaired. Uneventful recovery. Cause—full meal	1	
8. Stomach punctured with trocar. Operation—hole repaired. Uneventful recovery. Cause—dilated stomach (Hodgkin's disease)	1	
Total accidents	8	1.6
Deaths	1	2.7
Examination determined extensive metastatic carcinoma of liver. Biopsy specimen taken from nodule. Patient died 6 hours later of hemorrhage from biopsy wound in liver		
Summary		
Total cases examined	500	
Total complications and deaths	9	1.8
Unsuccessful examinations	3	0.6
Cause of failure to enter abdominal cavity in all 3 due to dense adhesions.		

TABLE III.—SUSPECTED CIRRHOSIS—140 CASES



	Cases	Per cent accuracy
Suspected clinically	140	
Actual cases proved	120	85.71
Peritoneoscopic diagnosis correct	114	95.00
Clinical errors — correctly diagnosed by peritoneoscopy—		
Malignancy	7	
Normal	7	
Tuberculous peritonitis	2	
Hepatitis	2	
Cholecystitis	1	
Passive congestion	1	
Total clinical errors	20	14.29
Peritoneoscopic errors—		
Malignancy	2	
Normal	2	
Hepatitis	1	
Incomplete examination	1	
Total peritoneoscopic errors	6	5.00

Per cent error

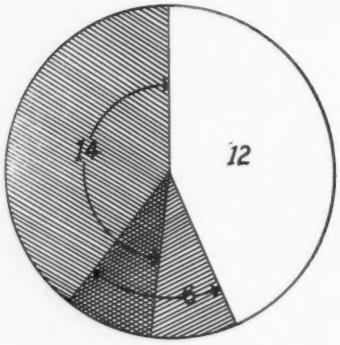
intestine may be punctured by this method, should it be firmly fixed to the parietal peritoneum by adhesions. Puncture of the bowel has occurred in my series of 500 cases 8 times (Table II). Each time the instrument has been left in place and an abdominal incision has been made. In each instance, the trocar could have been removed without soiling the peritoneal cavity, as the bowel was firmly plastered against the parietal peritoneum.

The death recorded, resulting from a fatal hemorrhage following a biopsy from a carcinoma metastatic nodule in the liver, occurred because of insufficient coagulation of the biopsy wound. Many biopsies have been taken since, but thorough coagulation of the wound is done, in all cases, whether bleeding is noted or not.

Due to extensive peritoneal malignancies and extensive adhesions from tuberculosis, cases will be encountered in which it is impossible to enter the abdominal cavity with a peritoneoscope. This has occurred three times in my series, once with malignancy and twice with tuberculosis. The peritoneoscope merely enters a small pocket walled off by adhesions, or it is impossible to produce a pneumoperitoneum in order to go ahead with the procedure. When such an abdomen is encountered, no attempt is made to insert the peritoneoscope. However, the finding of such a condition may accomplish the purpose for which the examination was intended.

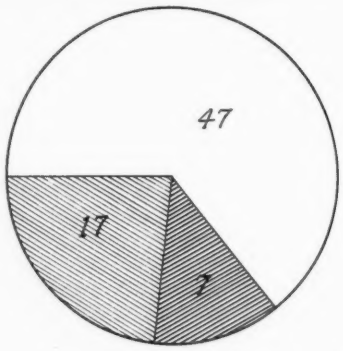
Hernia through the scar of the puncture wound has not occurred in my series of cases. Hematoma at the site of the puncture wound has occurred on two occasions.

TABLE IV.—SUSPECTED TUBERCULOUS PERITONITIS—32 CASES



	Cases	Per cent accuracy
Suspected clinically	32	
Actual cases proved	18	56.25
Peritoneoscopic diagnosis correct	12	66.67
Clinical errors—correctly diagnosed by peritoneoscopy—		Per cent error
Cirrhosis of the liver	4	
Carcinoma of the peritoneum	4	
Pelvic inflammatory disease	3	
Pelvic malignancy	1	
Postoperative adhesions	1	
Unsuspected	1	
Total clinical errors	14	43.75
Peritoneoscopic errors—		
Carcinoma of the peritoneum	1	
Pelvic malignancy	2	
Normal abdomen	1	
Unsuccessful	1	
Accident	1	
Total peritoneoscopic errors	6	33.33
Both in error	3	

TABLE V.—SUSPECTED PERITONEAL METASTASES—71 CASES



	Cases	Per cent accuracy
Suspected clinically	71	
Actual cases proved	54	76.1
Peritoneoscopic diagnosis correct	47	87.03
Clinical errors—correctly diagnosed by peritoneoscopy—		Per cent error
Tuberculous peritonitis	3	
Cirrhosis of the liver	4	
Postoperative adhesions	2	
Intestinal obstruction	2	
No metastases	2	
Ovarian cyst	1	
Unsuspected	3	
Total clinical errors	17	23.9
Peritoneoscopic errors—		
No metastases	3	
Lues	1	
Tuberculous peritonitis	1	
Unsuccessful	1	
Accident	1	
Total peritoneoscopic errors	7	12.97

ACCOMPLISHMENT OF PURPOSE OF EXAMINATION

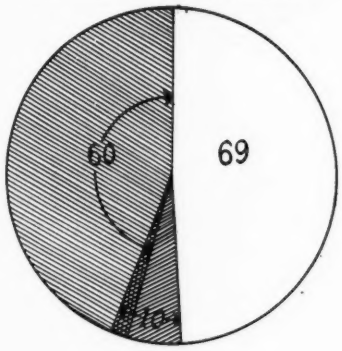
The procedure of peritoneoscopy should not be done without a definite purpose for which the examination is made. The procedure is then carried out in order to accomplish this purpose. To determine the presence of metastases, to corroborate a diagnosis, to differentiate and localize tumor masses, and to aid in differential diagnoses, are purposes of examination which justify the procedure.

If the purpose of examination is accomplished, then the examination is successful and justified. The procedure should not be expected to accomplish more than the purpose for which it is done.

PERITONEOSCOPIC STATISTICAL STUDY OF DIAGNOSTIC ACCURACY

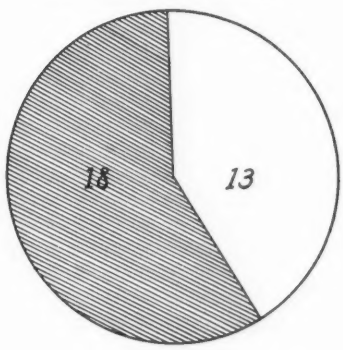
The compilation of statistics with regard to comparing accurately clinical methods of diagnoses and peritoneoscopic methods becomes exceedingly difficult. This is especially true when a case is referred for peritoneoscopy with four or five suspected clinical diagnoses. One may be correct, the others may be wrong, or all may be wrong and the peritoneoscopic diagnosis may be right or wrong. The accompanying tables reveal the percentage of clinical accuracy compared to the percentage of peritoneoscopic accuracy and list the errors in diagnosis for both methods. Selected for statistical study are suspected cases of tuber-

TABLE VI.—SUSPECTED MALIGNANCY OF THE LIVER—135 CASES



	Cases	Per cent accuracy
Suspected clinically	135	
Actual cases proved	79	55.6
Peritoneoscopic diagnosis correct	69	87.4
Clinical errors—correctly diagnosed by peritoneoscopy—		
Cirrhosis	34	Per cent error
Hepatitis	3	
Passive congestion	2	
Normal	9	
Chronic cholecystitis	2	
Postoperative adhesions	2	
Unsuspected	4	
Ovarian cyst	1	
Carcinoma of the ovary	1	
Abscess	1	
Hepar lobatum	1	
Total clinical errors	60	44.4
Peritoneoscopic errors—		
Cirrhosis	6	
Normal	2	
Abscess	1	
Passive congestion	1	
Total peritoneoscopic errors	10	12.6
Both in error	2	

TABLE VII.—SUSPECTED ECTOPIC PREGNANCIES—31 CASES



	Cases	Per cent accuracy
Suspected clinically	31	
Actual cases proved	13	42
Peritoneoscopic diagnosis correct	13	100
Clinical errors—correctly diagnosed by peritoneoscopy—		
Intra-uterine pregnancies	10	Per cent error
Intra-uterine pregnancies with pelvic inflammatory disease	4	
Pelvic inflammatory disease	3	
Ruptured ovarian cyst	1	
Total clinical errors	18	58
Total peritoneoscopic errors	0	0

culous peritonitis, peritoneal metastases, cirrhosis, malignancies of the liver (both primary and secondary), and ectopic pregnancies. This makes a total of 409 cases.

This is the number of cases conforming to the above diagnoses which have occurred in the series of 500 cases reported. The remaining 111 cases are made up of various diagnoses, a series of each of which is too small for making a statistical study.

The average clinical accuracy in the total series is 63.9 per cent, whereas the average peritoneoscopic accuracy is 91.7 per cent. The comparison for the individual case diagnosis is shown in the Tables III to VII.

Twenty-two cases of this series of ectopic pregnancies have been reported by Dr. Robert B. Hope in the February, 1937, issue of SURGERY, GYNECOLOGY AND OBSTETRICS. Dr. Hope has acted as my assistant during the past 3 years in the clinical examination of patients by peritoneoscopic methods.

SUMMARY

Peritoneoscopy should be selected in lieu of a diagnostic laparotomy where it is necessary to determine malignancies, metastases and extent of involvement, to differentiate tumor masses, and localize them, to examine the surfaces of viscera and pelvic organs, or to corroborate a diagnosis or to obtain biopsies. It should not be selected for use in cases with inflammatory lesions in the peritoneal cavity.

Peritoneoscopy is a minor procedure under local anesthesia, with practically no discom-

fort and small economic features, in contrast to a diagnostic laparotomy which is a major procedure requiring a general anesthetic, and entailing considerable economic features and variable discomfort.

The procedure cannot take the place of surgery, but, by making a definite and correct diagnosis, it may prove a valuable aid, if the case is an operable one and surgery is deemed necessary.

The value of this procedure becomes evident when we note that examinations may be made completely and accurately; biopsy specimens of tumor masses and tissues may be quickly, safely, and painlessly taken for diagnostic purposes, and exploration of poor surgical risks may be accomplished.

All patients with a diagnosis of cirrhosis, or suspected cirrhosis, of the liver, should be examined with the peritoneoscope for corroboration. A questionable diagnosis can often be excluded or confirmed, and a decision reached as to form, kind, and extent of the pathological process.

A definite purpose of examination is necessary to justify a peritoneoscopic examination. The procedure should not be expected to accomplish more than the purpose for which it is done.

The very practical results of this relatively simple method of examining the contents of the abdominal cavity with the eye should command for it, as a diagnostic procedure,the general use which the cystoscope now holds for the examination of the bladder and kidneys.

The peritoneoscopic accuracy, as noted in a statistical study of 409 case studies, is 91.7 per cent as compared to the clinical accuracy of 63.9 per cent.

The procedure of peritoneoscopy is a technical one and requires that the operator train himself in the details of the procedure and in the use of the instruments. He should be able to recognize and differentiate the macroscopic appearance of pathological processes when seen.

Appreciation is expressed to Drs. Robert B. Hope of Los Angeles, California, and Andrew B. Bonthius of Pasadena, California, for the assistance which they rendered in making the clinical exmination of the patients included in this series.

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HEMORRHAGIC OR TRAUMATIC CYSTS OF MANDIBLE

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THE great majority of cysts of the jaw bones originate in abnormal development of cells derived from the enamel organ of the tooth, and have a capsule lined with epithelium. However, one is occasionally surprised to find a case, especially in the mandible, in which a cavity exists in the bone, containing fluid, but in which no lining membrane apparently is present. It is well known that non-epithelial cysts occur in the long bones of the extremities in connection with osteitis fibrosa, and also following trauma, which latter have been explained on the basis of hematoma formation. According to Blum, to whom we are greatly indebted for information in preparing this paper, Boetticher and Beneke were the first to conceive of a traumatic hematocyst developing in a previously healthy bone. Their findings were confirmed by von Haberer and Pommer, who described the mechanism and the pathology. Briefly, the process is one of intramedullary hemorrhage from trauma insufficient to cause fracture, in a young bone. To quote Thoma: "The intra-osseous blood clot causes pressure on the vessels, producing stasis. The decomposing fibrin, in turn, causes an irritation, which results in resorption of the bony trabeculæ of the spongiosa. This produces a large cavity in the central part of the bone . . . the cyst increases in size by displacement of the spongiosa." Hemorrhagic cysts, comparable to cysts found in the long bones as a result of trauma, have been reported in the mandible. All cases described have been in adolescents; most of them have been apparently due to intramedullary hemorrhage following trauma insufficient to cause fracture or escape of blood into the surrounding soft tissues. Probably the first mention of such a condition was made by Lucas in 1929; he described x-ray and operative findings which are in conformity with the reports of later writers. Other cases have been mentioned by Schneider, Thoma, and Blum. Blum was the first in this country to describe the pathology of these lesions, showing their correspondence in every respect with the hemorrhagic cysts of the long bones.

The cavity in the bone is apparently unconnected with the teeth, although the roots of the latter may be secondarily involved. It is filled with decomposed blood and later with clear serous fluid, and at operation clinical examination shows no lining membrane, the walls of the cavity being apparently bare. In Blum's cases, however, histological examination of the bony wall showed that a thin lining was present, consisting of blood vessels embedded in a loose framework of connective tissue fibers and a compressed layer of dissolved red corpuscles. Osteoblastic and osteoclastic changes in the bony walls were also seen.

The *diagnosis* may be difficult. It depends on a history of trauma—sometimes quite vague, in a young patient, insufficient to cause fracture, with later development of dull pain, and sometimes a swelling of the body of the mandible; x-ray findings of a well defined, somewhat irregular cavity in the bone along the course of the inferior dental canal, with no apparent connection with the roots of the teeth, the pulps of the latter being vital. Differentiation from dental root cysts and dentigerous cysts may be practically impossible before operation, unless the x-ray shows definite connection of the roots of a pulpless tooth or of the crown of an unerupted tooth with cyst cavity. At operation the absence of a definite epithelial membrane characteristic of the cysts of dental origin is at once evident.

Benign giant cell tumor offers another difficulty, but usually shows x-ray evidence of bony trabeculæ running through the tumor

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Fig. 1, left. Case 1. Roentgenogram before operation, showing clearly defined cavity in mandible, not involving the roots of the teeth.
Fig. 2. Case 1. Roentgenogram made 3 years after operation, showing obliteration of cyst cavity by new bone.

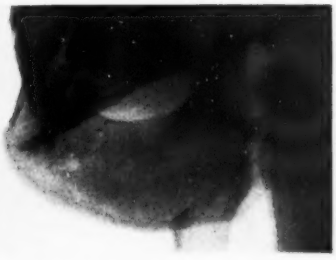

Fig. 3, left. Case 2. Roentgenogram before operation.
Fig. 4. Case 2. Roentgenogram made about a year after operation, showing bone regeneration.

mass. The rapid development after trauma often leads to fear of sarcoma. If necessary, the cystic character of the swelling can be demonstrated before operation by aspiration.

Treatment consists in opening into the bone cavity after exposure through a flap of gum or through skin incision, and evacuating the fluid contents. The cavity is preferably kept open and allowed to heal by granulation.

Blum states that these cysts would probably respond favorably to aspiration of their fluid contents, but rightly favors wide opening and evacuation, as in this way only the presence or absence of an epithelial membrane can be determined. Also, if cyst wall bulges, aspiration alone might not cause collapse and restore the normal contour of the bone.

To the cases previously reported by Lucas (1 case), Schneider (3 cases), Blum (3 cases) and Thoma (2 cases), we wish to add 4 of our own. It is to be noted that 3 of our cases were in sons of physicians, though of course this is merely a coincidence.

Case 1. H.S., aged 10 years, male, was referred by Dr. E. P. Pendergrass in February, 1931, on account of a swelling of the left side of the mandible. This had been noticed for about 6 months and seemed to be slowly increasing in size but gave only slight discomfort. There was a vague history of a blow received on the jaw 2 years before. There was no history of trouble with the teeth on that side of the lower jaw and examination showed the premolar and first molar teeth normally erupted, and pulps vital. Beneath these teeth there was an oval swelling the result of thinning and expansion of the outer cortical plate and lower border of the bone, which yielded easily to pressure on the skin. X-ray examination (Fig. 1) revealed a clearly defined cavity in the bone beneath the incompletely calcified roots of the premolar and molar teeth, the latter, however, not being exposed in the bone cavity. The lower border of the bone was exceedingly thin and bulged convexly downward. General physical examination, blood chemistry, etc., were normal.

At operation at the Graduate Hospital, February

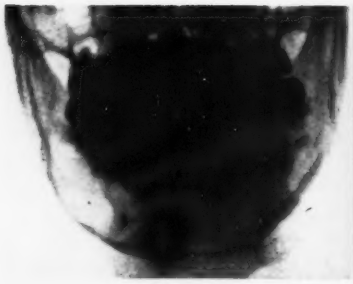

Fig. 5.

Fig. 6.

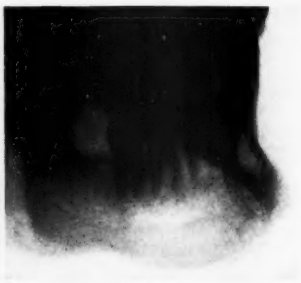

Fig. 8.

Fig. 7.

Fig. 5. Case 3. Anteroposterior x-ray view showing cystic cavity in left side of mandible.

Fig. 6. Case 3. Lateral view of mandible, before operation.

Fig. 7. Case 3. Dental x-ray films showing details of cyst formation in region of roots of teeth.

Fig. 8. Case 3. Roentgenogram made 1 year after operation, showing bone regeneration.

13, 1931, under general anesthesia, because we desired not to injure the attachment of apparently normal teeth, a skin incision was made over the convex lower border of the swelling, and a portion of the paper-like lower bony wall was removed. A quantity of clear, straw-colored fluid was immediately discharged, after which it was possible to examine the interior of the cavity. This had apparently bare bony walls, with no lining membrane as is present in cysts of dental origin. The tooth roots were seen to be covered by a thin layer of bone. The cavity was lightly packed with gauze, which was replaced several times until healing occurred. Subsequent x-ray studies (Fig. 2) showed a gradual filling in of the cavity with new bone.

CASE 2. R.P., male, aged 19 years, was first seen by us on March 15, 1935. Almost 3 weeks previously, while playing basketball, he received a hard blow from an opponent's shoulder on the left side of the lower jaw. He did not recall any previous injury to the jaw. After the injury he had pain and some swelling of the left side of the jaw, with slight elongation and tenderness of the molar teeth. No fracture of the jaw was found. A few days after the injury the first molar tooth was removed in an effort to relieve the pain, but the latter continued. On examination, very little swelling of the left side of the mandible was evident, but the bone was tender and the second molar was quite sore to the touch. The pulps of the remaining teeth were vital. X-ray examination by Dr. W. C. Westcott (Fig. 3) showed a large cavity with fairly well defined margins in the left side of the mandible extending from beneath the premolars to the third molar region. The third molar was unerupted with uncalcified roots, but did not have any connection with the bone cavity, thus eliminating the diagnosis of a dentigerous cyst. The roots of the other teeth were apparently not involved in the bone cavity. March 28, 1935, 5

Fig. 9. Case 4. Roentgenogram of right side of mandible, showing cyst cavity before operation.

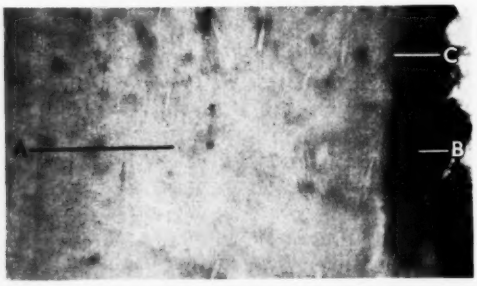

Fig. 10. Photomicrograph of section of bony wall of cyst removed at operation. *A*, Compacta; *B*, hemorrhagic coagulum; *C*, osteolytic absorption lacunae (Dr. H. R. Churchill).

weeks after the injury, at Presbyterian Hospital, under general anesthesia an incision was made in the gum on the outer side of the teeth in the left lower jaw. Some of the very thick outer plate of the mandible was removed, thus exposing a cavity in the bone extending below the molar and premolar teeth. This cavity was apparently filled with old blood, and no lining membrane was present; it evidently represented an early stage of hemorrhagic cyst formation. A small gauze pack was inserted in the opening. Packing was discontinued after a few days and the wound in the mouth was allowed to close. This case has been characterized by persistent pain, somewhat relieved by later removal of the second molar tooth, but even at the present time there is a dull ache in the jaw. Later x-ray examinations have revealed a progressive filling-in of the cavity with new bone, until at the present time the outlines of the cavity are barely discernible (Fig. 4).

CASE 3. R.W.H., male, aged 20 years, first consulted us on February 10, 1936, the condition of the lower jaw having been discovered about a month previously during a routine x-ray examination of the teeth. No pain or other symptoms was complained of; patient could recall no definite injury to the jaw. Careful palpation revealed a slight thickening of the body of the mandible on the left side. The teeth showed no abnormalities except a large filling in the first molar. The pulps of the teeth were vital.

X-ray examination showed a large, well defined cavity in the left side of the mandible, extending from the canine to the third molar, apparently not involving the roots of the teeth (Figs. 5 and 6). Dental films showed definite bony plates covering the roots, isolating them from the cavity (Fig. 7).

February 13, 1936, at Presbyterian Hospital, under general anesthesia, a skin incision was made beneath the lower border of the mandible. The very thin external plate was removed, and a large bone cavity exposed, containing clear fluid and no lining. The inferior dental nerve and vessels, and the finer nerves and vessels going to the roots of the teeth, were seen. A rubber dam drain was inserted and the incision partly closed. The drain was left out after 10 days. Pathological examination of the bony wall showed nothing of special interest, except disintegrated blood débris on its inner surface. X-ray examination a year later revealed practically complete regeneration of bone (Fig. 8).

CASE 4. H.H., female, aged 13 years, was first seen on October 6, 1936. Six months before, she had received a blow on the lower jaw to the right of the symphysis. The overlying tissues at the time became swollen and discolored, but no fracture of the mandible was found and no special treatment was given. The acute swelling gradually became less, but some enlargement to the right of the chin persisted. For the past few weeks she had complained of considerable pain in the right side of the lower jaw, probably due to a carious molar tooth.

The patient was a well nourished girl, with no complaints or abnormalities except in the region of the lower jaw. The contour of the lower part of the right side of the face was seen to be more prominent than that of the left side. Examination inside the mouth revealed a smooth, non-tender bulging of the lingual and buccal plates of the right side of the mandible, extending from the first molar to the canine tooth. The overlying mucous membrane was normal. There were no abnormalities of the teeth except a carious cavity in the first molar. X-ray examination showed a clear cut cavity in the right side of the mandible extending from first molar to canine region, not involving roots of teeth (Fig. 9).

October 15, 1936, at Presbyterian Hospital, under ether anesthesia, an incision was made in the gum over the outer aspect of the right side of the mandible from the first molar to the canine, beneath the roots of these teeth, and the soft tissue flap was reflected downward. The thin outer bony plate was easily removed, exposing a large irregular cavity in the bone, filled with clear, straw colored fluid. No soft tissue was present in the cavity. The roots of the teeth were covered with a thin plate of bone and the vessels and nerves could be seen running to their apices from the main trunks. Nothing more was done beyond lightly packing the cavity with gauze. The packing was discontinued after a few days and the wound gradually healed. Examination of a portion of the thin bony wall showed normal compact bone with a hemorrhagic coagulum and some evidence of osteolysis on its inner surface (Fig. 10).

SUMMARY

Attention is called to certain cystic conditions of the mandible, due to trauma insufficient to produce fracture, but causing intramedullary hemorrhage with disintegration of cancellated bone and cavity formation. These are comparable in every way to traumatic cysts of the long bones, having no epithelial lining characteristic of cysts of dental origin.

Since the preparation of this paper we have encountered a fifth case in a girl of 16 years, involving the right side of the mandible, similar in every respect to those reported in detail, and operated upon on May 14, 1937.

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PITUITARY BASOPHILISM

A Review of 42 Verified Cases, With a Report of a Personal Case

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DURING the past 5 years increasing interest and attention have been drawn to an endocrinopathy, more commonly affecting women, in which the adrenal glands seemingly play a prominent rôle. The syndrome referred to is characterized chiefly by hirsutism, obesity, especially of the face, abdomen, and trunk, osteoporosis, cutaneous striæ, and hyperglycemia.

Since 1756, when William Cooke (quoted by Oppenheimer) described a case manifesting this syndrome, numerous cases have been described in the literature under various designations. As examples: Alfred Gallais in 1912 described the syndrome and termed it "le syndrome génito-surrénal," and Krabbe in 1921 outlined the syndrome which he designated "adrenal hirsutism."

In 1921, Achard and Thiers, likewise, discussed an endocrine condition which they named "diabetes of bearded women" and which was characterized by hypertrichosis of the face, obesity, hypertension, and amenorrhea. At autopsy hyperplasia of the adrenal glands was usually noted in these patients.

The causation of this syndrome until 1932 was generally considered to be an overactivity of the suprarenal glands, induced either by simple hyperplasia of the glandular structure or by functionally active adenomas or other types of neoplasms.

Recently, patients manifesting this syndrome have been observed who recovered completely following the removal of portions of hyperplastic adrenal glands or the enucleation of adrenal adenomas. Walters and associates, in 1934, recorded 2 cases in which the successful removal of suprarenal tumors brought about disappearance of all symptoms and return of the physical appearance of the patients to normal.

On the other hand, there are recorded reports of bilateral exploratory operations on the adrenal glands in patients with this syndrome in whom no gross evidence of suprarenal tumor, hypertrophy or hyperplasia could be found. Two cases of this type were reported by Walters and his co-workers in which biopsy of specimens removed during operation from each adrenal gland exhibited no evidence of hyperplasia on microscopical examination. Subsequent autopsy examination of the pituitary gland from one of these patients, who died 1 year later, disclosed an adenoma of the anterior lobe, 5 millimeters in diameter, composed of basophilic cells.

In another patient recently described by Crile and his associates, a girl, aged 17 years, who manifested the chief symptoms and signs of Cushing's syndrome, improved remarkably following bilateral denervation of the adrenals and a partial adrenalectomy of one gland. However, when the patient died 18 months later from acute epicarditis, autopsy revealed a chromophobe adenoma of the pituitary with possibly scattered basophilic cells. The adrenal glands showed a reduction of cortical tissue and fibrosis.

The aforementioned and other similar cases recorded in the literature suggest the thought that the adrenal glands are not the only organs concerned in the production of this syndrome.

In 1932, Harvey Cushing (13) collected 14 cases, in which the clinical picture was similar to that manifested by patients with tumor or hyperplasia of the adrenal cortex. Ten patients were found to have basophilic adenomas of the pituitary body and the remainder had tumors which could not be definitely classified. Frequently the adrenal cortex was found to be hypertrophied.

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With respect to the presence of a basophilic adenoma in the pituitary gland in cases of the syndrome, Cushing (13–17) in his treatise on the subject states:

> Some of these syndromes have unquestionably been due to cortico-adrenal tumors and in not a few instances, indeed, such a tumor has been removed at operation with definite amelioration of symptoms. What is more, in similar states, suprarenal tumors have been found after death in the absence of any recognizable abnormality in the pituitary body, though all too often the protocol refers to the examination of this structure, either in the briefest terms or not at all. While there is every reason to concede, therefore, that a disorder of somewhat similar aspect may occur in association with pineal, with gonadal, or with adrenal tumors, the fact that the peculiar polyglandular syndrome, which pains have been taken herein conservatively to describe, may accompany a basophil adenoma in the absence of any apparent alteration in the adrenal cortex other than a possible secondary hyperplasia, will give pathologists reason in the future more carefully to scrutinize the anterior pituitary for lesions of similar compositions.

Two examples of adenomas of the anterior pituitary composed of basophilic elements were first described by Erdheim in 1903. In one, a basophilic adenoma 1.5 millimeters in diameter, was found in a woman 40 years old, who showed symptoms of Basedow's disease. In the other, a tiny basophilic adenoma in association with an eosinophilic adenoma was discovered in the pituitary gland. This dual neoplasm occurred in an acromegalic patient 43 years of age.

Since the early report of Erdheim, a number of investigators have recorded the finding of basophilic adenomas of the hypophysis during postmortem study in patients dying from various diseases. Among these may be mentioned Simmonds, Christeller, Naegeli and Susman.

Microscopic study of hypophyses removed during routine necropsy examination of persons meeting accidental death or dying from causes, apparently of non-pituitary origin, have disclosed a rather high incidence of adenomas of the pituitary gland. A study of serial sections of the pituitary bodies of 127 patients, none of whom had presented Cushing's syndrome, by Brauchli in 1927, disclosed an incidence of 21 or 3.1 per cent adenomas, including 3 of the basophile type. R. T. Costello likewise made a similar study of 1000 pituitaries removed during routine autopsy examinations and found 40 basophilic adenomas, an incidence of 4 per cent. These studies were later confirmed by Susman, who found an incidence of 22 adenomas among 260 pituitaries, 8, or 3.1 per cent, being composed of basophilic elements, and he, therefore, concluded that this incidence of basophilic adenoma is too great to be of any special significance.

In this study we have made an exhaustive search of the literature, and collected so far as possible all recorded cases manifesting the well known symptoms of this syndrome in which autopsy or operation revealed the presence of an adenoma of the anterior pituitary gland. We have thus far succeeded in collecting 42 cases which have been tabulated in Table I.

Cases which clinically belong to this group but in which the patients are alive or in which autopsy has not been performed have not been included in this analysis, but will be considered in a subsequent report.

Since the spring of 1934 we have had under observation a patient who manifested many of the symptoms of pituitary basophilism and who received pituitary irradiation.

CASE REPORT

The patient, aged 20 years (Figs. 1 and 2), an unmarried female, was first seen on April 10, 1934. Her chief complaint was swelling of the face and feet, irregular menstrual periods, growth of hair on the face associated with an extensive acne-like skin eruption. She had in September, 1933, been observed in the Vanderbilt Clinic, New York City, where a diagnosis of pluriglandular syndrome was made.

Her menstrual cycle which began at the age of 13 years was regular for 5 years and then became irregular. The periods recurred about every 3 or 4 months and lasted 2 or 3 days. Her last period, before coming under observation, occurred in February, 1934. She began to gain weight about a year previously, and it increased from 120 to 132 pounds. She suffered deep mental anguish because of the skin eruption and the hirsuties on her face. She also became psychically depressed and physically inactive.

Other prominent symptoms were extreme dryness of the skin, falling of the hair on the scalp, puffiness of the eyes, frequent urination, polydipsia, and marked redness of the face. Occasionally she complained of pain in the arms and legs, and swelling of the ankles.

a b c

Fig. 1. a, Photograph of patient with pituitary basophilism, taken in 1932 prior to onset of symptoms. b, Photograph taken in 1935. The acneform eruption is visible, but the hairy growth has been decolorized by the patient. c, Photograph taken March 3, 1937, following deep pituitary irradiation. Note the loss of adipose tissue in the face and chest, the improvement in color of the skin, and disappearance of the acne.

On physical examination, the most striking feature was the obesity of the face, and upper part of the trunk and back.

The face assumed a round or "moonlike" appearance. The skin was tense and of a vivid hue. There was an abnormal growth of hair, especially visible on the sides of the forehead, upper lip, and chin. There was an acneform eruption of the face, extending over the upper portion of chest, both anteriorly and posteriorly. The breasts were of normal development, but showed several striæ. A fine hirsuties was present over the lower abdomen. The distribution of the pubic hair tended toward the masculine type.

Rectal examination disclosed the uterus to be of normal size and in an anterior position.

The systolic blood pressure was 130 millimeters and the diastolic 80 millimeters. At no time did the systolic pressure exceed 135 millimeters. The blood count showed 4,600,000 erythrocytes, 7,000 leucocytes, and 87 per cent hemoglobin. The differential white cell count was normal. The Wassermann blood reaction was negative. The basal metabolism test, performed on April 12, 1934, was plus 9 per cent. The cranial roentgenogram made by Dr. John T. Farrell, Jr., showed a sella turcica definitely enlarged, and a thinning out of the posterior clinoids. A blood sugar study (arterial blood) showed the following:

	mgms.
First determination (fasting)	118
One-half hour after glucose	190
One and one-half hours after glucose	250
Two and one-half hours after glucose	250

(One hundred grams of glucose given by mouth with 200 cubic centimeters of water.)

The patient was referred to the dermatological department for local treatment of the skin eruption, since the appearance of the face was causing her mental depression bordering on a psychosis.

When the patient first came under observation, a diagnosis of pituitary deficiency was tentatively made. Accordingly, she was referred to Dr. Farrell for irradiation of the pituitary gland with factors of treatment as follows:

1934	Filter mm. aluminum	Milliamperes	Spark	Time min.	Distance cm.	Area
May 15	4	5	9	2½	12	Right skull
May 15	4	5	9	2½	12	Left skull
May 22	4	5	9	2½	12	Right skull
May 22	4	5	9	2½	12	Left skull

Roentgenograms taken of the spine, pelvis, and extremities disclosed no evidence of decalcification.

The blood cholesterol was 188 milligrams, the blood calcium was 11.2 milligrams, and the blood phosphorus was 2.8 milligrams. Ophthalmological studies showed slight contraction of the visual fields. Retinal examinations were negative.

During the course of study, the patient had a menstrual period in May. Extraction of 60 cubic centimeters of urine did not show the presence of prolan.

The patient's psychical state improved considerably concurrently with improvement in the dermatological condition. She became much brighter mentally and obtained a position as a stenographer. There was, however, little or no improvement in the swelling of the face or ankles or in the hirsutism.

Because of the failure of general improvement following low dosage irradiation given in May, 1934, and the persistence of the edema of the ankles,

swelling of the face, persistent hirsutism, mental depression, polyuria, polydipsia, etc., pituitary basophilism was strongly suspected. She was then referred to the roentgenologist for a series of deep irradiation of the pituitary gland, and received the following course of treatment:

1934	Filter		Milliamperes	Spark kv.	Time min.	Distance cm.	Area
	Copper	Aluminum					
June 12	½	1	8	200	8	50	Right skull
June 12	½	1	8	200	8	50	Left skull
June 26	½	1	8	200	4	50	Right skull
June 26	½	1	8	200	4	50	Left skull

Two months following this recourse there was noticed considerable general improvement. The redness and swelling of the face had decreased, the swelling of the ankles had disappeared entirely. The patient was mentally normal and became very active. The facial hirsuties did not improve, and the patient had not menstruated since May, 1934. However the improvement did not continue, and in January, 1935, the only permanent change noted was the disappearance of the swelling of the ankles.

An intravenous pyelographic study was then made to determine, if possible, the presence of an adrenal neoplasm. This study was entirely negative. Extraction of a 24 hour specimen of urine also failed to disclose a determinable amount of estrin.

These two studies negated the presence of an adrenal neoplasm. She was again referred for pituitary irradiation and received 100 per cent skin erythema dose or 650 r to each side of the skull between January 27, 1935, and February 28, 1935.

The factors in the roentgen treatment were as follows:

135 kv., 5 ma., 40 cm., and 6 mm. Al. filter.

Shortly following this administration, she was examined by Dr. Harvey Cushing, who concurred in the diagnosis of pituitary basophilism and recommended another course of pituitary irradiation which was given by Dr. Farrell as follows:

1935	Milliamperes	Kilovolts	Copper	Aluminum	Distance cm.	Time min.	r units	Pituitary
April 24	8	200	½	1	50	13	300	Right
April 26	8	200	½	1	50	13	300	Left
April 29	8	200	½	1	50	13	300	Right
May 1	8	200	½	1	50	13	300	Left

Two months following this series of treatments there was decided improvement in the endocrine symptoms. Hirsutism appeared to be diminished, polyuria was reduced, and the patient had a general feeling of well-being.

In September, 1935, she received another course of pituitary irradiation, consisting of 300 r units to each side of the head on alternate days for four sessions. No further improvement was noticed in the appearance of the face after this course of irradiation.

Fig. 2. Author's case of pituitary basophilism responding to deep roentgen therapy of the pituitary gland. Note the "moon-shaped" appearance of the face and striæ on breasts.

The basal metabolic rate was minus 7 per cent, and she was given ½ grain of thyroid extract three times daily. Another roentgen examination of the wrists, lower portion of the radii, ulnæ, lower portion of the femora and tibiæ presented no evidence of decalcification or bony pathological changes.

From March 31, 1936, to April 16, 1936, she was given another course of deep pituitary irradiation to the left and right pituitary region on six occasions under the supervision of Dr. B. P. Widman. She received 300 r units to the right and left temporal area at each treatment with the following factors:

200 kv., ½ mm. Cu., 10 by 10 cm. field, for a total of twice 1800 r units.

TABLE I.—VERIFIED CASES OF PITUITARY BASOPHILISM

Case	Author Year	Chief symptoms								Other symptoms	Pathological findings			Treatment	Cause of death
		Age Sex	Obesity	Amenorrhea	Hirsutism	Abdominal striæ	Glycosuria	Skeletal decalcification	Hypertension		Pituitary	Adrenals	Other glands		
1	Schmorl; Molineus 1913	48 F	Yes	Yes	Yes			Yes			Large basophilic adenoma	Not mentioned	Colloid goiter. Atrophic gonads		
2	Anderson 1915	20 F	Yes	Yes	Yes			Yes	Yes	Asthenia	Basophilic adenoma	Hypertrophy and adenoma	Senile gonads. Atrophic thymus		Asthenia
3	Reichmann 1919	36 F	Face	Yes	Yes			Yes	Yes		"Eosinophilic" adenoma	Hypertrophy	Small thyroid. Atretic gonads	Partial adrenalectomy	Died after operation, peritonitis
4	Cushing (Miss L.) 1921	45 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Large invasive adenoma	Hypertrophy	Atretic gonads		Pituitary operation
5	Zondek 1923	24 F	Yes	Yes	Yes	Yes	Yes	Yes			Small adenoma	Not mentioned	Atretic gonads		Erysipelas
6	Raab; Kraus 1924	31 M	Yes	Impotence	None	Yes	Yes	Yes		Headache	Basophilic adenoma	Autolysis	Thyroid enlarged. Gonads, no sperm. Fatty parathyroids		Sepsis
7	Parkes, Weber 1926	28 F	Yes	Yes	No	Yes			Yes	Dyspnea; exophthalmos, nephritis	Basophilic adenoma	Normal structure	Atretic gonads		Pulmonary edema
8	J. Bauer 1930	30 F	Yes	Yes	Yes	Yes	Yes	Probable	Yes	Increased metabolism	Basophilic adenoma	Normal		Adrenal operation	Erysipelas, postoperative
9	Wieth-Pedersen 1931	24 M	Yes	Impotence	None	Yes	Yes	No evidence	Yes	Dyspnea, cardiac hypertrophy, headache, ecchymoses	Adenoma (nongranular elements)	Hypertrophy	Colloid thyroid		Pulmonary dyspnea
10	Teel 1931	20 F	Yes	Irregular menses	Yes			None		Increased metabolism, weakness	Basophilic adenoma	Hypertrophy	Enlarged thyroid	Thyroid irradiation	Meningitis
11	Cushing (Miss P.) 1932	33 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Lowered metabolism	Basophilic adenoma	Hypertrophy	Atretic gonads		Pulmonary edema
12	Moehlig 1932	43 F	Yes	Castrate	Yes	Yes			Yes	Psychosis, nervousness, ecchymoses Headache, increased metabolism	Basophilic adenoma	Not examined	Not examined	Thyroidectomy	Cardiac failure postoperative
13	Bishop; Close 1932	22 F	Yes	Yes	Yes	No	Yes	Yes	Yes		Basophilic adenoma	Not mentioned	Atretic gonads		Pulmonary edema
14	Berblinger 1932	? F	No	Castrate	Yes	Yes	No				Basophilic adenoma	Hypertrophy			
15	Salus 1933	? F	Yes	Yes	Yes	Yes	No			Polydipsia, polyuria, headache, respiratory paralysis	Malignant adenoma	Hypertrophy	Atrophic ovaries	Pituitary operation	Died, postoperative

TABLE I.—VERIFIED CASES OF PITUITARY BASOPHILISM—Continued

Case	Author Year	Chief symptoms								Other symptoms	Pathological findings			Treatment	Cause of death
		Age Sex	Obesity	Amenorrhea	Hirsutism	Abdominal striæ	Glycosuria	Skeletal decalcification	Hypertension		Pituitary	Adrenals	Other glands		
16	Rutishauser 1933	42 F	Yes	Yes	Yes	Yes		Yes	Yes	Edema of legs, cardiac hypertrophy	Basophilic adenoma	Hypertrophy	Fatty parathyroids	Medical	
17	Rutishauser 1933	23 F	Yes	Yes	Yes	Yes				Mentally deficient, dyspnea, pulmonary edema	Increase in basophilic cells	Not mentioned	Fatty parathyroids. Atrophic gonads	Thyroid	Not mentioned
18	Rutishauser 1933	65 F	Yes	Postmenopausal				Yes	Yes	Polyneuritis (alcoholic), ascites	Basophilic adenoma	Not mentioned	Fatty parathyroids Laënnec's cirrhosis Colloid goiter		
19	Marburg 1933	26 M	Yes	Diminished potency		Yes	Yes	Yes		Fatigue, pains in legs, vertigo	Basophilic adenoma	Not mentioned			
20	Craig and Cran 1934	28 F	Yes	Yes	Yes	Yes	No	Yes	Yes	Headache, dyspnea, pains in extremities	Basophilic adenoma	Hypertrophy		Pituitary irradiation	Bronchopneumonia
21	Russell, Evans and Crooke 1934	? M	Yes	Impotence	No	Yes		No		Headache, nephritis, ecchymoses	Basophilic adenoma	Not mentioned			Nephritis
22	Russell, Evans and Crooke 1934	? F	Yes	No	Yes	Yes			Yes	Nephritis	Basophilic adenoma	Hypertrophy			Nephritis
23	Josephson and Bergstrand 1934	42 F	Yes	Hypomenorrhea	Yes		Yes			Emotional disturbance, dyspnea, cyanosis	Basophilic adenoma	Hypertrophy	Cystic ovaries	Exploratory operation	
24	Raab 1934	44 F	Yes		Yes		No	Yes	No	Kyphosis, abdominal pains, bronchopneumonia	Basophilic adenoma	Normal	Colloid goiter		
25	Greppi and Redaelli 1934	? F	Yes	Menopausal	Yes				Yes	Dyspnea, weakness, cyanosis	Basophilic hyperplasia	Hyperplasia	Atrophic ovaries		
26	Walters, Wilder and Kepler 1934	34 F	Yes	Yes	Yes	Yes			Yes	Headache, edema of extremities	Basophilic adenoma	Normal		X-ray to pituitary and thymus, partial adrenalectomy	Pneumonia, 3 months after operation
27	Klein 1935	33 F	Yes	Yes	Yes			Yes		Depression, sepsis	Basophilic adenoma	Hyperplasia			
28	Jonas 1935	32 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Tachycardia, pains in legs, fatigue, headache	Basophilic adenoma	Not mentioned	Adenoma of parathyroid. Atrophic ovaries		

TABLE I.—VERIFIED CASES OF PITUITARY BASOPHILISM—Continued

Case	Author Year	Chief symptoms								Other symptoms	Pathological findings			Treatment	Cause of death
		Age Sex	Obesity	Amenorrhea	Hirsutism	Abdominal striæ	Glycosuria	Skeletal decalcification	Hypertension		Pituitary	Adrenals	Other glands		
29	Minciotti 1935	38 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Headache, cardiac failure, pains in legs	Basophilic adenoma	Normal	Hyperplastic thyroid and parathyroids. Atrophic ovaries		Cardiac failure
30	Hildebrand 1935	58 M	Yes	Loss of libido		Yes	Yes	Yes	Yes	Dyspnea, polydipsia, edema of feet, lumbago, polyuria	Basophilic adenoma	Small adenoma of cortex	Atrophic testicles. Adenoma of thyroid	Pituitary irradiation	
31	Horneck 1935	23 M	Yes	Loss of libido	Feminine type	Yes	No	Yes	No	Dyspnea, pains, debility	Small adenoma (eosinophilic)		Atrophic testicles	Medical	Cardiac failure. Tuberculous pleurisy
32	Hora 1935	38 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Pains in extremities	Basophilic adenoma	Hyperplasia and small adenoma	Enlarged parathyroids. Atrophic ovaries	X-ray	
33	Gouley 1935	37 F	Yes		Yes		Yes	Yes	Yes	Dyspnea, headache	Basophilic adenoma		Sclerotic ovaries	Medical	Cerebral apoplexy
34	MacCallum, et al. 1935	25 F	Yes	Yes	Yes	Yes	Yes	Yes		Dyspnea, polyuria	Basophilic adenoma	Enlarged (normal)			Died after pyelocystoscopy
35	Lisser 1935	28 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Atypical chromophobe adenoma	Patient living		Operation	Recovery after operation
36	Lescher 1935	32 F	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Microscopic basophilic adenoma	Carcinoma of adrenals			Died after adrenalectomy
37	Wright 1935	11 M	Yes			Yes	Yes			Convulsions, headache, abdominal pains	Basophilic adenoma	Hyperplasia and adenoma	Normal parathyroids	X-ray	Died after appendectomy
38	Swan and Stephenson 1935	30 F	Yes	Yes	Yes			Yes	Yes	Renal colic	Basophilic adenoma	Hypertrophy		Medical	Renal colic
39	Lawrence and Zimmerman 1936	44 M	Yes			Yes		Yes	Yes	Ecchymoses, ruptured aneurism of aorta, kyphosis, coronary occlusion	Basophilic adenoma				Aortic aneurism
40	Fuller 1936	20 M	Yes	Loss of libido		Yes	No	No	Yes	Mentally depressed, polyuria	Chromophobe adenoma	Normal		Operation on adrenals. X-ray to pituitary	Postoperative
41	Freyberg 1936	19 M	Yes	Loss of libido		Yes		Yes	Yes	Polyuria, polydipsia	Basophilic adenoma	Normal	Ovaries atretic, fatty parathyroids	1600 r pituitary irradiation. Adrenal operation	Pulmonary edema. Pneumonia, septicemia
42	Crile 1936	17 F	Yes	Oligomenorrhea	Yes	Yes		No	Yes	Fatigue, nervousness, headache, polycythemia	Chromophobe adenoma with scattered basophilic cells	Reduction of adrenal tissue		Adrenal denervation, partial adrenalectomy	Acute epicarditis (1½ years postoperative)

From June 2, 1936, to June 30, 1936, she received 5 treatments with the same factors, but with a field of 4 by 5 centimeters for a total of 2 times 750 r units to the right and left temporal region and direct to the pituitary region. At this time roentgenography showed the sella turcica to be normal, and there was no roentgen evidence of rarefaction in the bones of the right arm or right leg.

No immediate results were noticed after this course of deep irradiation. There was a loss of hair at the site of irradiation. The blood calcium study showed 9.6 milligrams per 100 cubic centimeters. Roentgenogram of the sella turcica disclosed it to be within normal range.

In October, 1936, the patient again consulted Dr. Harvey Cushing at the New Haven Hospital. While under his observation, roentgenographic study of the adrenal glands was made with negative results. Since then, there has been a steady and progressive improvement in the hirsutism and obesity. The patient has lost 13 pounds in weight and on January 26, 1937, weighed 122 pounds. The cyanotic color and acne of the face have completely disappeared. The swelling of the face has been reduced remarkably. There has also been a decided improvement in the posture; the tendency to kyphosis having disappeared. A period occurred in October, 1936, but not since. Probably the improvement was the result of the last course of deep irradiation of the pituitary gland.

This patient exhibited the prominent features emphasized by Cushing as being manifestations of basophilic adenoma of the pituitary body. These are in the order of their importance: (1) plethoric obesity of the face, (2) hirsutism, (3) amenorrhea, (4) cutaneous striæ, and (5) metabolic disturbances.

Obesity. The obesity with swelling of the face was the most conspicuous feature in our patient. The change that occurred in the appearance of the face may be observed in comparing the photographs in Figure 1. Obesity of the face and trunk, with tendency toward kyphosis, was present in the entire group of cases recorded in Table I, with one exception.

Hirsutism. This symptom was noted in 29 of the female patients. It is often the chief complaint of patients suffering with this endocrinopathy. The abnormal growth of hair occurs on the sides of the face, upper lip, and on the chin. There is usually a growth of hair on the lower portion of the abdomen assuming masculine type of distribution.

Amenorrhea. Amenorrhea was the most constant menstrual disturbance noted; this finding being present in 23 cases. Four patients were either menopausal or postmenopausal or had been castrated by previous operation, whereas, in only 1 patient was amenorrhea noted as being absent. (Loss of libido or sexual impotence was a constant finding in the male, 8 patients.)

Skeletal decalcification. Although skeletal decalcification has been observed in the majority of reported verified cases, at no time did our patient exhibit any clinical signs or roentgen findings suggesting osteoporosis. This may possibly be attributed to the early institution of deep irradiation of the pituitary gland. Skeletal decalcification was detected by roentgenography or found at autopsy in 27 cases, or 80 per cent of the 33 cases, recorded in Table I, in which this finding was mentioned.

Age. The ages of the patients, at the time of the reports, ranged from 11 years to 65 years.

Sex. This syndrome is overwhelmingly more commonly encountered and recognized in the female.

In the cases herewith recorded, there were 32 in females and 10 in males.

Other symptoms. Hypertension was noted in 25 cases or 86 per cent of the 29 cases where this symptom was recorded. Abdominal striæ were observed and recorded in 27 cases. Among other prominent symptoms noted may be mentioned: asthenia, headache, dyspnea, psychosis, emotional disturbances, polydipsia, polyphagia, ecchymoses, pains in the extremities, tachycardia, and convulsions.

Laboratory findings. The basal metabolic rate seemingly had no pronounced alteration in the reported cases, being low in some and high in others. No marked changes in the calcium content of the blood are accompaniments of basophilism. A number of the patients showed high values of blood calcium, while the calcium level was within normal limits in others. Polycythemia has been noted in several of the reported cases.

OUTCOME

Pulmonary complications and symptoms referable to the cardiovascular system were a common feature in the cases described. For example, the termination in 8 or 24 per cent

of the 30 patients in whom the cause of death was recorded, was by pulmonary edema or cardiac failure.

That patients with pituitary basophilia cannot withstand operative measures and are poor risks for any type of surgical procedure is shown by the fact that 9 patients succumbed after operation of one type or another. Five patients were operated upon for suspected adrenal neoplasm, and they all died following partial or total adrenalectomy (Freyberg, Lescher, Fuller, Reichmann, and Bauer). It is of absorbing interest to note that in only one of these patients was an adrenal neoplasm found at operation. Later at autopsy a minute basophilic adenoma was discovered in the pituitary gland (Lescher). One patient, described by Moehlig, died following thyroidectomy. Of 2 patients operated upon for the removal of pituitary tumor, one succumbed, while the other made a good recovery with cessation of the symptoms (Lisser). One patient, who had improved somewhat as a result of pituitary irradiation, died subsequently after an appendectomy (Wright). One case terminated fatally from infection following direct pyelocystoscopy.

Patients with this peculiar endocrinopathy are, in addition to being poor surgical risks, also liable to various types of general as well as dermatological infections; 2 patients died of erysipelas and 1 from sepsis as a result of a severe skin infection.

DIAGNOSIS

Since, in numerous cases reported in the literature, similar clinical phenomena may be found associated with or due to neoplasm of the adrenal cortex, the diagnosis of pituitary basophilism must rest on the exclusion of adrenal cortical tumor or hypertrophy. There is an increasing number of cases in which operative removal of adrenal cortical neoplasms has resulted in complete recovery with disappearance of the distressing symptoms. However, cases are recorded in which exploratory operations have resulted in death of the patients without the disclosure of any trace of either adrenal hypertrophy or neoplasm.

To avoid accidents of this nature, it is extremely important to direct all efforts of therapy toward the pituitary gland before entertaining any operative procedure on the adrenal glands.

Since basophilic adenomas of the pituitary body are so small that bony alterations are not, as a rule, produced, roentgenography of the sella turcica is of no aid in the diagnosis of the condition. Likewise, contraction of the visual fields has only occasionally been observed in cases of pituitary basophilism. There was only slight contraction of the visual fields, taken repeatedly, in the patient herewith reported.

A recent perfection in the technique of roentgenography has become an important adjuvant in the diagnosis of tumors and hypertrophy of the adrenal gland. The x-ray is of special value in cases in which no palpable mass is present. Recently, a method has been developed of visualizing the suprarenal gland by the injection of a measured amount of air directly into the perirenal space by hand pressure (Cahill). This worker found that the injected air would more or less slowly infiltrate through the fascial planes so that exposures 12 to 36 hours later would show the organ and fascial planes clearly, especially around the adrenal gland. This method has been found of value in demonstrating both the pathological as well as the normal adrenal gland.

PATHOLOGY

Forty-one of the 42 patients studied in this survey were examined post mortem, and microscopic examination was made of the hypophyses. A chromophobe adenoma was removed successfully by operation in the case reported by Lisser. A specific diagnosis of basophilic adenoma was made in 35 cases, while only an "increase in basophilic cells" was reported in 1 case.

Two of the neoplasms were described as "eosinophilic" adenomas, and in 1 case reported by Cushing (13), the tumor was noted as a "large invasive adenoma."

In the case reported by Wieth-Pedersen (58), an adenoma composed of non-granular elements was found at autopsy, while chromophobe adenomas were disclosed in the cases reported by Fuller and Crile.

Postmortem study of the suprarenal glands was completed and recorded by 29 authors in

29 cases. Hyperplasia or hypertrophy of the adrenal cortex alone or with definite adenomatous formation was a strikingly frequent occurrence. Varying degrees of hyperplasia or hypertrophy were encountered in the removed adrenal glands of 18 patients, or 63 per cent of the 29 cases, and in addition to hypertrophy, a definite adenoma of the cortex was found in 4 cases (Anderson, Wright, Hildebrand, and Hora).

The adrenal glands were noted as entirely normal in only 8 instances, or an incidence of 26 per cent.

Carcinoma of the adrenal gland was found in 1 case (35), while hypoplasia of the suprarenal cortex was present in Freyberg's case.

The high incidence of secondary hyperplastic changes in the adrenal glands in pituitary basophilism may, according to Cushing (17), bear the same causative relationship to basophilic adenomas of the pituitary as do the frequently associated adenomas of the adrenal cortex to acidophilic adenomas of acromegaly.

Atrophy or atresia of the ovaries was a common finding, being reported in 16 cases.

A fatty condition of the parathyroids was also a fairly common necropsy finding.

In Schmorl's case, there was observed hyperplasia of the parathyroids without adenomatous formation.

In several cases there was found an enlargement of the thyroid or a colloid goiter.

In many of the cases reported, the thymus gland was atrophic, in some it was replaced by fat, and in a few it was normal in size. In the cases reported by Teel and Freyberg, the thymus glands were hyperplastic and definitely enlarged. The rôle played by the thymus in this syndrome is probably not important, although several cases are on record in which neoplasms of the thymus were associated with a clinical syndrome identical with basophilia (Leyton, 36; Kepler).

With respect to the pathology of Cushing's disease, Crooke (25) states "that the only factor common to the syndrome, regardless of whether the pituitary or adrenal gland be the site of tumor formation, is a hyaline change in the basophilic cells of the anterior hypophysis which apparently is not an expression of altered physiological activity."

In association with the chromophobe adenoma of the pituitary gland reported by Fuller there was noted hyaline change in the cytoplasm of the basophile cells.

In 3 cases of Cushing's syndrome reported by Rasmussen, in which no pituitary adenoma was found, but in one of which a carcinoma of the adrenal gland was present, the pituitary sections showed extensive hyaline changes in the basophiles of the anterior lobe and in some of the basophiles of the posterior lobe. These nuclear changes were also noted by Hare and his associates in the pituitary gland removed from a patient with carcinoma of the adrenal gland.

MacCallum and his co-workers found in their case of basophile adenoma that the basophile cells of the neoplasm, as well as those of the pars intermedia, remained unstained with copper hematoxylin, whereas the basophiles of the anterior lobe stained black. For this reason, they believe the tumor is derived from the pars intermedia cells.

Recently, Cushing (16) has demonstrated the presence of basophilic infiltration of the pars nervosa of pituitary glands in 6 fatal cases of eclampsia. In 4 cases in which the patients had shown marked hypertension, an excessive basophilic infiltration of the posterior pituitary gland was found. A similar condition has been observed by Cushing in a number of glands from fatal cases of essential or nephrovascular hypertension. The hypertension, as well as the other effects, such as the derangements of fat, carbohydrates and water metabolism (obesity, hyperglycemia, edema, polydipsia, polyuria) encountered so regularly in pituitary basophilism, are doubtless manifestations of posterior lobe activation resulting from the secretory activity of the basophilic cells.

However, controversial evidence exists only regarding the character of the endocrine principle produced by the overactive basophilic elements. Zondek, for example, concludes in his study that prolan is derived from the basophilic elements of the anterior lobe. Anselmino and his co-workers showed that the blood of eclamptic patients with edema and hypertension contains antidiuretic and pressor substances. They believe that an overproduc-

tion of posterior pituitary hormone offers the only proper explanation of the posterior pituitary phenomena met with in basophilism, eclampsia, and essential hypertension.

It, therefore, is justifiable to assume, for the time being at least, that the hypertensive disorders and sequelæ as well as posterior pituitary manifestations encountered in basophilia have their source in the posterior lobe of the pituitary body, and that the symptoms are induced by secretory activity of the excessive production of basophilic elements.

TREATMENT

In cases in which the syndrome is present, coinciding with that found in the verified cases of pituitary basophilism, treatment should be directed to the pituitary gland. Exceptions to this rule should be made only in those cases in which definite evidence of adrenal neoplasm is obtained.

The best procedure, in cases in which the causative lesions cannot definitely be determined, is to administer deep roentgen therapy to the pituitary. If prolonged thorough roentgen treatment of the gland fails to bring about progressive improvement in the endocrine condition, exploratory operation on the adrenal glands may then be considered.

Roentgen therapy had been employed in 7 cases described in Table I. In the case reported by Wright, noticeable improvement in the health of the patient took place following x-ray therapy until death intervened after an appendectomy.

Two courses of deep roentgen therapy were applied to the pituitary gland in the case described by Craig and Cran, but death from pneumonia occurred before improvement was noted.

Roentgen therapy had been used in several other cases listed in our study, but the patients had been so seriously affected by cardiovascular and other organic changes that death supervened before the effect of this method of therapy could be evaluated.

Radiation of the pituitary gland has, in some instances, caused the disappearance of all the abnormalities in patients showing the symptoms of this syndrome. In the cases reported by Jamin, Wohl, and others, pronounced improvement followed deep x-ray therapy. The question of x-ray treatment of unverified cases, however, is a subject which will be discussed in a later report.

On the assumption that the manifestations of Cushing's syndrome are due in large part to adrenal hyperactivity, Crile and associates have performed denervation and partial resection of the adrenal glands in cases of this character and obtained alleviation of the symptoms.

Oppenheimer states that it seems to him, "in a particular case after a tentative trial of roentgen therapy to the brain without improvement, one should explore both adrenals surgically, possibly, also the ovaries, seeking to find a tumor, the removal of which may cure the patient." On the other hand, Kepler and associates who obtained some degree of success in operative removal of adrenal adenomas, and resection of hyperplastic adrenal tissue, believe it a better plan to operate first on the adrenal glands and to treat the pituitary gland later, if no pathological alteration in the adrenals is found. However, this procedure, it seems to the writers, may unnecessarily expose the patients to the dangers of surgical maneuvers which may not prove of benefit.

SUMMARY

1. The clinical course of a personal case of pituitary basophilism in a girl 20 years old under observation for a period of 3 years is described. Osteoporosis and hypertension, two symptoms usually found, were not present in the case recorded. The patient made a pronounced improvement after receiving several courses of deep roentgen irradiation to the pituitary gland.

2. The special features of 42 verified cases of pituitary basophilism are tabulated and analyzed. A definite diagnosis of basophilic adenoma was made in 35 cases; an increase in basophilic cells was reported in 1 case. A chromophobe adenoma was successfully removed by operation in 1 case. In the 5 remaining patients, the pituitaries disclosed adenomas composed of chromophobe or eosinophilic elements.

3. Thirty-two patients were female, and 10 were male.

4. The most conspicuous clinical features of basophilic adenoma are as follows: (1) plethoric obesity, especially of the face, (2) hirsutism, (3) amenorrhea (impotence or loss of libido in the male), (4) cutaneous striæ, (5) osteoporosis, (6) hypertension, and (7) glycosuria.

5. Other symptoms of prominence are: headache, asthenia, pains in the extremities, polyphagia, polydipsia, and symptoms referable to the cardiovascular and respiratory systems.

6. Death in the recorded cases was usually due to infections of various types or pulmonary complications. Patients with basophilic adenoma of the pituitary cannot withstand any type of infection, not even one of a minor nature.

7. Hypertrophy of the adrenals was an associated finding in 18 or 63 per cent of 29 cases in which the adrenal condition was described. In 3 cases definite adenomas of the adrenals were also present. The association of adrenal hypertrophy and adenomas is also encountered and has long been known to be a definite association of acromegaly.

8. Five patients were operated upon for suspected adrenal neoplasms and all died following operation. In only 1 patient was an adrenal tumor found to be present at the time operation was performed. Later at autopsy a minute basophilic adenoma was discovered in the pituitary gland.

9. Therapy for patients exhibiting the manifestations of Cushing's syndrome should consist in deep roentgen (high voltage) irradiation of the pituitary gland. Irradiations of high dosage should be employed (300 to 1200 r units to each side of the head). This should be repeated every 4 to 6 months, if only slight or no improvement occurs. Patients with this syndrome apparently withstand large exposures of irradiation very well and show no ill effects.

10. Finally, the authors believe that patients with the clinical syndrome of pituitary basophilism should not be exposed to the risks of adrenal exploration, unless definite evidence of tumor is found, or repeated high voltage irradiation therapy has failed to bring about improvement.

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ROENTGENTHERAPY IN EPITHELIOMAS OF THE MAXILLARY SINUS

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AT THE present time the technique most widely used in the treatment of epitheliomas of the superior maxillary region is an atypical resection of the superior maxilla, either by cold steel or diathermy, followed by irradiation of the cavity by means of tubes of radium placed in the interior of the operative field. Telecurietherapy or roentgentherapy, before or after operation, however, are used in addition in certain clinics. These procedures give an appreciable percentage of cure in expert hands.

In a total of 72 patients with epitheliomas of the maxillary sinus, admitted for treatment at the Foundation Curie from 1919 to 1934, a small group of 10 patients was treated by roentgentherapy alone. It is this group of patients which forms the basis of this work.

CLINICAL STUDY

The early diagnosis of epitheliomas of the maxillary sinus is exceptional. The tumor forms in a cavity where it can develop silently without causing symptoms. At times there is a slight serous discharge from the nose which, unassociated with pain, is confounded with simple coryza. Sometimes, in those forms arising in the suprastructure of the maxilla, the patient notes, 2 or 3 months before the first painful symptoms, nasal hemorrhage which may last for several hours, yet which rarely leads to an early diagnosis.

The alarming symptoms appear when the tumor invades the neighboring regions and opens a tract from the sinus. These symptoms vary according to the site of origin of the growth. A classification of these sites of origin is thus necessary and of importance both in arriving at a diagnosis and in deciding upon the method of treatment.

Suprastructure. Tumors which arise in the superior half of the maxillary sinus at the onset have the most dormant development. As soon as they invade the orbital cavity, however, the distortion of the region makes the diagnosis easy. These tumors fall into two groups: the external and the antero-internal.

Tumors of the suprastructure which grow *externally* arise in the summit of the pyramid shaped antrum. They rapidly invade the malar bone, but cause only slight infra-orbital pain. A tumefaction of the external angle of the floor of the orbit then appears and there is an associated infra-orbital, frontal, and temporal pain, which increases as the tumor grows larger. Invasion of the orbital cavity is brought about by infraction of the external part of the orbital floor. The eye is deviated upward and inward, the palpebral fissure becomes oblique from within outward and from below upward (Figs. 6 and 8). The temporal fossa is affected by invasion of the zygomatic process or through the external wall of the orbit. Adenopathy, rare in these cases, is limited to a small pre-auricular gland.

The *antero-internal* tumors arise on the uppermost portion of the anterior wall of the sinus at the junction with the nasal fossa. The patient complains of slight infra-orbital pain and there is a progressively increasing nasal discharge and obstruction. One frequently finds in these patients large polyps involving the turbinates; the polyps may have been removed on several occasions but without establishing the diagnosis of neoplasm. The tumor gradually deforms the infra-orbital region, the lacrymal sac becomes infected, suppurates, or is invaded, and pain—infra-orbital, medial, frontal, and parietal—sometimes very intense, makes its appearance (Fig. 1).

The invasion of the floor of the orbit results from the infraction of the internal half. The eye is displaced upward and outward, tending more and more to become exteriorized. The anterior ethmoidal cells are affected from the

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Fig. 1. Epithelioma of the suprastructure of the maxilla. Antero-internal form.

Fig. 2. Epithelioma of the infrastructure of the maxilla. Antero-external form.

beginning, as is at times the frontal sinus. We have never observed adenopathy in this form.

Infrastructure. Infrastructure tumors develop in contact with the dental roots and their nerves. Alarming symptoms are therefore observed earlier in the course of development than in those tumors of the suprastructure. However, although the patient may consult his dentist early, the diagnosis of neoplasm is often established late.

Antero-external tumors arise in the anterior part of the sinus, at the union of the antero-external wall and the septum dividing the sinus and the nasal fossa. The patient may seek consultation because of pain of dental origin which may accompany the loosening of the tooth; a premolar or the first molar tooth may be affected. After extraction of the tooth the pain persists. The diagnosis of dental cyst may then be made, and it is often during the course of operation for this cyst that the real diagnosis is made.

Development of the tumor first takes place anteriorly and laterally, becoming so large that at times there is considerable disfigurement to the maxillary region (Fig. 2). The naso-antral wall and the inferior turbinate are displaced medially, thus gradually obstructing the nasal cavity.

Invasion of the hard palate through the alveoli and the displacement of the mucosa into the gingivobuccal sulcus progresses rapidly without eliciting very great pain. Submaxillary adenopathy is observed often in these patients and especially after buccal invasion has begun.

Posterior tumors arise at the junction of the postero-inferior and internal walls of the sinus. It is the rarest form and that in which the diagnosis is most tardy. Pain is often the first symptom and is diffuse. Its cause is usually attributed to an accident to a wisdom tooth, an unerupted tooth, or a dental cyst. Trismus often appears early or closely follows the pain. The posterior molars become loose and fall, if they have not already been extracted due to an error in diagnosis.

The tumor grows inwardly toward the pterygomaxillary fossa and the swelling is noticed externally. Ethmoidal invasion takes place through the posterior ethmoidal cells. Superior carotid and angulomaxillary adenopathy is not rare.

Secondary infection. These tumors have a marked tendency to spontaneous necrosis and once having opened into the buccal cavity or nasal fossa, they present a large gangrenous

surface, infected, and with a necrotic odor. This secondary infection is neither a contraindication nor an obstacle to treatment.

It has been noted that all the tumors of the buccopharyngeal regions—voluminous, proliferating, infected, and malodorous—benefit greatly by irradiation, which seems to be for them the most efficacious of disinfectants. Moreover, many of these tumors are highly sensitive to radiotherapy.

Infection associated with epithelioma of the maxillary sinus in particular becomes an obstacle only when the infection involves the other sinuses thus provoking a purulent pansinusitis.

Malignancy. Although these tumors are considered to be highly malignant, they seem to react differently; in fact, (1) no instance of distant metastasis has been observed; (2) invasion of the glands is rarely early; (3) patient remains in good general condition for a long time.

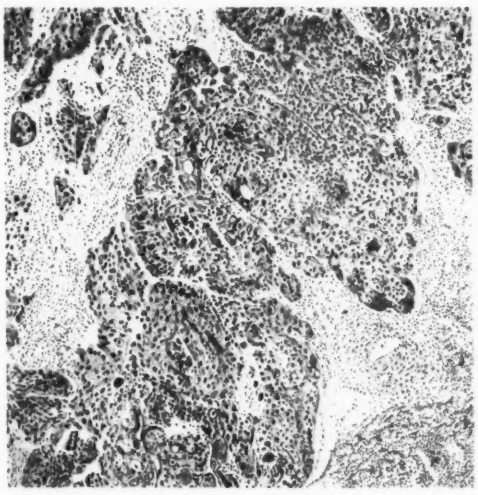


Fig. 3. Epidermoid pavement epithelioma of the maxillary sinus. Variety of epithelioma most often encountered. ×50

ROENTGENOGRAPHY

Roentgenographic study of the maxillary sinus is of great value in establishing the true extent of the lesion. The tumors, on clinical examination, often appear localized to one or another portion of the maxillary structure, but with the x-ray they are found to be of much greater extent. The roentgenogram reveals not only the extent of the invasion, but the condition of the maxillary and malar bones, of the floor of the orbit, of the hard palate; at times it reveals that the lesion has spread even into the pterygomaxillary fossa. These facts are not always brought out in the clinical examination nor does the symptomatology reveal them.

Roentgenographic examination often demonstrates an opacity of the ethmoid cells and frontal sinus. In the absence of bone infraction or destruction, this opacity does not indicate definitely a neoplastic invasion of these regions. It does point to the possibility of such an invasion and is an indication that these regions should necessarily be included in the field of irradiation.

HISTOPATHOLOGY

The majority of tumors of the superior maxilla are epitheliomas. The lymphosarcomas found in this region are usually the result of propagation from tumors arising in the nasopharynx. The proportion of connective tissue tumors to epitheliomas is about 1 to 10. For a long time benign giant cell tumors of the maxilla have been included with the connective tissue tumors of the region, and thus it came to be believed that connective tissue tumors were as frequent as epitheliomas. In reality such tumors are rare.

Epitheliomas of the maxillary sinus which arise from a cylindrical mucosa susceptible to metaplasia, in the great majority of cases, belong to the group of *epidermoid pavement epitheliomas.* They have the characteristics of tumors which arise from epidermal coverings: stratification of the cellular elements and successive transformation of these to resemble elements of the skin and dermopapillary mucosæ. Eight of our 10 cases belong in this group. In addition they all present a *mucosal type of epidermoid evolution*, with stratification most often complete, sometimes alternating, but with basal cells predominating, and with keratinization by foci or isolated cells rather than by the formation of epithelial pearls (Fig. 3).

Large, clear cells presenting monstrosities

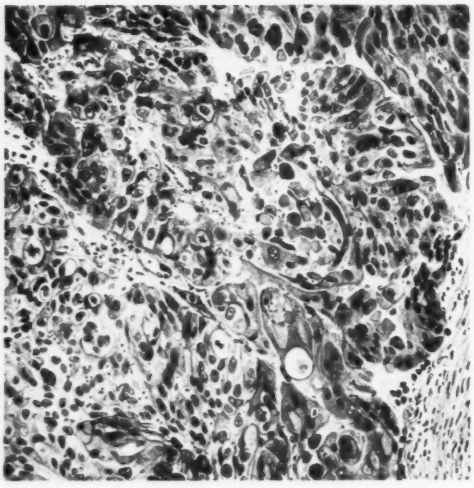


Fig. 4. Epidermoid pavement epithelioma of the maxillary sinus. Same case as in preceding figure. ×170

are often observed, recalling those seen in epitheliomas recently irradiated (Fig. 4). Mitoses are usually numerous. Spontaneous necrosis in the center of the sheets of cells is frequent.

Two of our cases were *non-epidermoid epitheliomas*. One was composed of small uniform cells, architecturally arranged in large sheets or conjoined nodules, and proved to be very radiosensitive. The other was a massive epithelioma which had invaded the muscle, and contrary to the finding in the first case, was only slightly radiosensitive.

TREATMENT

All these patients were treated by roentgenotherapy alone, for the reason that it would have been impossible to remove the lesion completely no matter how extensive the surgical extirpation.

Dental extractions. A wise precaution is to extract before treatment all the teeth of the superior and inferior maxillæ of the affected side no matter what their condition and as well all other teeth of the opposite side in questionable repair. We believe that it is preferable to extract generously. Teeth in bad condition are often the cause of early necrosis of the maxilla. One of our patients refused extraction, and at the completion of treatment presented necrosis of the inferior maxilla; its origin and development from and around a dental root could be followed.

Following irradiation of tumors of the pharynx and oral cavity, very often late dental lesions are observed, even in the teeth which are in good condition before irradiation. These dental lesions, which vary in severity and in rapidity of development, at times constitute multiple portals of entry for infection which, when it reaches the irradiated maxilla, may cause a late necrosis and jeopardize the cure of the patient. A patient who had been pronounced cured of an epithelioma of the hard palate returned 6 months after treatment presenting dental lesions which had caused necrosis of the inferior maxilla. We have just observed two other patients who were cured of epitheliomas of the tonsil 8 years ago and who developed dental lesions. At the present time both patients have necrosis, one patient of the inferior maxilla, the other of the superior maxilla.

We believe, therefore, that in all patients subjected to irradiation of the oropharyngeal regions, the safest procedure is to remove all teeth, especially if the teeth are not in good condition and to await for complete healing of the gums before irradiation is begun. One is often obliged to be content with a less radical procedure.

Physical factors. The voltage employed has been from 180 to 200 kilovolts. If the tumor remains localized and especially if it is superficial, it seems sufficient to sterilize these tumors. The intensity of the secondary current in the tube has been 3 to 4 milliamperes; it is probable, however, that these forms of cancer with relatively slight differentiation could be treated without ill effect with higher intensities.

The anticathode skin distance we use is 50 to 60 centimeters. The average hourly dose has been from 150 to 250 r per hour, or 2.5 to 4 r per minute. The filtration has been 2 millimeters of copper and 3 millimeters of aluminum.

Portals of entry. Two unilateral fields of 70 to 120 square centimeters have most often been used—one anterior and the other lateral,

each covering the entire primary lesion. There is therefore a large zone of superimposition. Sometimes a third field, with the rays applied over the opposite side has been used, but the first two portals of entry are the most important and usually suffice.

If there exists a submaxillary or carotid adenopathy, it may not be practicable to include both the primary lesion and the gland area in one field. In such cases, it may be preferable to use an additional field to cover the gland area. If the adenopathy is only suspected or is not voluminous, it can be treated after the primary lesion.

Ocular protection. In the lesions limited to the infra-maxillary structure of the superior maxilla, the eye is outside the zone of invasion, hence is not irradiated. In the extensive cases, however, or in those in which the growth is limited to the suprastructure, the eye is in contact with the neoplastic mass and must necessarily be subjected to irradiation.

If the eye receives the total dose necessary to sterilize the tumor, there is produced a more or less serious injury to the eye, depending on the intensity of the treatment:

1. If treatment consists of intense daily doses given over a short period of time, there is produced an ulcer on the cornea which, in the months following treatment, may necessitate enucleation.

2. If the treatment is of moderate intensity, the eye may remain intact, but there is a definite epilation of the lids accompanied by chronic conjunctivitis with tearing which can be more uncomfortable to the patient than the loss of the eye.

3. If the treatment is of low intensity, there is no definite epilation of the lids and the patient conserves normal vision. At the end of 2 or 3 years, however, the vision becomes less acute and finally is lost.

If the treatment is prolonged over several weeks, the eye can be protected after the first portion of the irradiation has acted upon the periphery of the tumor. In one of our patients, Case 7, who received 7300 r in 42 days, the eye was protected after having received 2500 r in the first 25 days of treatment and normal vision is conserved at the present time, 5 years after treatment (Fig. 9).

Fig. 5. Epithelioma of the suprastructure of the maxilla treated by roentgentherapy in 12 days, Case 2. Loss of eye. Late radionecrosis of skin healed. Cure of 15 years' duration.

The fields are irradiated without protection of the eye of the affected side, during the first 3 or 4 weeks of treatment, during the course of which a dose of about 2000 to 2500 r is administered. Irradiation is then continued but the eye is protected by means of a shadow projected on it by a lead rod 5 millimeters in thickness and 1.5 centimeters in diameter, which, placed at a distance of 15 to 20 centimeters from the eye in the beam of the rays, stop those rays which could otherwise fall directly upon the eye and on the borders of the lids (protection at a distance). Toward the end of the treatment one adds to this protection an oval shell of lead encased in wax, 3 millimeters in thickness and 2.5 by 3 centimeters in diameter, which is placed either directly in front of, or lateral to, the eye in the path of the anterior or lateral beam (direct protection).

Prolongation of treatment. The duration of the treatment depends upon the clinical conditions in the individual case and upon the anatomical characteristics of the region irradiated. For instance, epitheliomas histologically slightly differentiated, as those of the maxillary sinus, can be sterilized as well by treatment over a short period of only 15 days as over a longer period of 40 to 50 days.

Figs. 6 and 7. Case 4. Epithelioma of the suprastructure of the maxilla, external form. Roentgentherapy in 18 days. Loss of vision of left eye 2 years after treatment. Atrophy and telangiectasis of skin. Cure of 7 years' duration. At left, taken in 1930; at right, in 1937.

On the other hand, the anatomy of the region and the conservation of healthy tissue traversed by the beam leads one forcibly toward treatment prolonged over several weeks. Our conclusions from cases treated are as follows:

1. Treatments extending over a period of 2 weeks or less rarely produce sterilization of the neoplasm; in fact, if sterilization is secured it is at the expense of the eye, which must be enucleated. Also there are the concomitant radio-necrotic accidents to the skin or bone from which the patient does not always survive. Such short courses of treatment are not advisable even when only palliative treatment is attempted, for they provoke a rapid sloughing of the neoplasm and this is followed by a lowering of the general condition. Death may result very rapidly from such a procedure, especially in older patients.

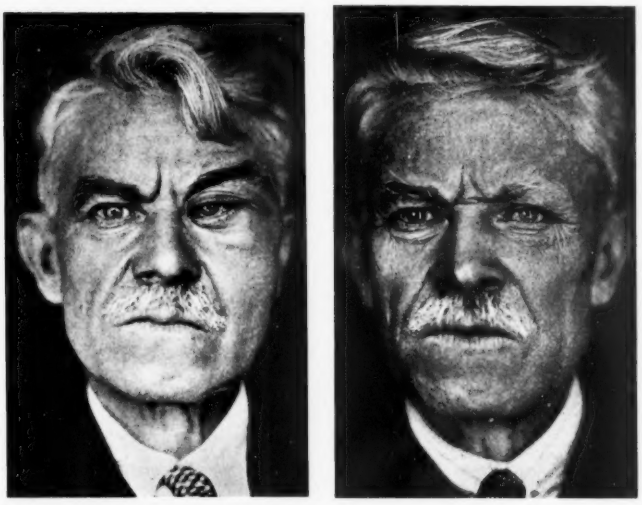
2. Treatment extended over 3 to 4 weeks can produce sterilization but there is always the possibility that vision in the irradiated eye will be sacrificed because in treatment over such a short period of time protection of the eye might compromise the cure; moreover, skin modifications—atrophy, telangiectasis, sclerosis—are always marked.

3. Treatment extended over 5 to 6 weeks permits of sterilization under the most favorable conditions, with conservation of the eye and vision because the eye can be protected during part of the treatment. Skin modifications are minimum or absent, and the cosmetic results are perfect.

4. Treatment prolonged over more than 6 weeks gives an appreciable palliative result, especially in a very advanced case, with the patient in poor general condition, but sterilization of the tumor is rarely accomplished and is usually followed by recurrence. However, recurrence is very slow in contrast to the rapid development of the tumor before treatment.

Clinical control during treatment. Daily observation and examination of patients are without doubt the most important factors in the conduct of treatment. It is only by closely following the patients that one can adapt the daily dose to the exigencies of the varying local and general conditions; rarely does a patient benefit from routine treatment. Individual peculiarities as to ocular, skin, and cutaneous reactions are among the factors which demand the daily careful examination of the patient.

Total dose. The total dose administered



Figs. 8 and 9. Case 7. Epithelioma of the suprastructure of the maxilla, external form. Roentgentherapy in 42 days. Conservation of vision. No trace of irradiation on skin. Cure of 5 years' duration. At left, 1932; at right, 1937.

varies with the period of time covered in the treatment. A dose of 4000 r—measured on the skin—given in 14 days through two fields on the same side of the face, causes at times great suffering both local and general; but a dose of double that magnitude, 8000 r given under the same conditions but over a period of 87 days, as in one of our patients, was insufficient to sterilize the neoplasm, but caused no local or general accidents.

For a treatment extending over 5 or 6 weeks, the total effective dose seems to vary between 6000 and 7000 r administered through two fields on the same side of the face. These doses closely approach the limits of danger.

Daily dose. Almost all of our patients have received continuous treatment, daily or twice daily; the average dose has thus varied, depending on the prolongation of the treatment, between the extreme limits of 130 to 700 r per day.

In a continuous treatment, extending over 5 to 6 weeks, the average daily dose is 200 to 250 r, but this dose must not and cannot be systematically applied day by day. It represents only an average of the total treatment. The daily dose must pass from maximum to minimum, depending upon the effect of the irradiation.

Reactions. Beginning with the first days of treatment the external portions of the tumor are covered with false membranes—an indication of the characteristic sensitiveness of this type of tumor. Even with low daily doses these false membranes often persist until the total disappearance of the neoplasm.

If the treatments given are of moderate or high dosage, there appears between the twelfth and fifteenth days a reaction of the normal mucosa, a mucosal radio-epithelitis involving the mucosa of the gingivobuccal sulcus and extending finally to the palate and upper lip. If at this time the treatment is stopped or the daily dose is lowered, the mucous reaction disappears after 7 to 10 days. However, if the high dosage treatment is continued, the condition tends to persist.

At the end of the fourth week the epidermis, which has become very red over the cheek, is denuded; a radio-epidermitis is produced which is usually exudative in type, due to the two superimposed fields on the antero-external part of the cheek. Complete healing takes place in 8 to 10 days. In extended treatments

Fig. 10. Case 6. Epithelioma of the infrastructure of the maxilla and submaxillary and carotid adenopathy. Treated by roentgentherapy in 48 days. Palatine perforation closed. No trace of irradiation on skin. Cure of 6 years' duration.

the radio-epidermitis results at times in only dry desquamation.

The lids and conjunctivæ also react, becoming edematous and congested, with epilation of the lids. Care must be used in such cases to avoid infectious complications.

STUDY OF RESULTS

The radiosensitivity of epitheliomas of the maxillary sinus is generally great, about equal to that of the lympho-epitheliomas.

Five of our 10 patients had very extensive tumors and none of these has survived (Table I). Two of these patients died 2 or 3 weeks after treatments of short duration which brought a general weakened condition. Two others died, one 6 months and the other 18 months after treatment, with recurrence complicated by necrosis of the maxilla. Finally, the last patient died 18 months after treatment extending over almost 3 months, followed by gradual recurrence.

The 5 other patients had lesions more or less localized in the suprastructure or infrastructure of the maxilla. Four of these patients remain cured, the longest period being 15 and the shortest 5 years. Two of these tumors were of the infrastructure: one, Case 10, after treatment and local healing, developed submaxillary adenopathy of rapid evolution and the patient died 6 months after

TABLE I.—SUMMARY OF PATIENTS TREATED

Case	Series	Year	Sex age	Side	Clinical condition	Histology	Duration treatment	Results
1	IX-A-20	1920	F 74	R	Very extensive. No adenopathy	Non-epidermoid epithelioma	14 days	General condition enfeebled. Died 10 days after treatment of cardiac complications
2	IX-A-25	1922	M 53	L	Suprastructure. No adenopathy	Epidermoid epithelioma	12 days	Loss of eye. Late radionecrosis of skin. *Cure of 15 years' duration*
3	IX-A-65	1928	M 42	L	Very extensive. No adenopathy	Epidermoid epithelioma	15 days	Early necrosis of inferior maxilla of dental origin. Recurrence and necrosis of superior maxilla. Died 16 months after treatment
4	IX-A-69	1930	F 62	L	Suprastructure. No adenopathy	Epidermoid epithelioma	18 days	Loss of vision 2 years after treatment. *Cure of 7 years' duration*
5	IX-A-70	1930	M 57	R	Very extensive. No adenopathy	Epidermoid epithelioma	16 days	General condition enfeebled. Died 3 weeks after treatment
6	IX-A-73	1931	M 56	L	Infrastructure. Submaxillary and cervical adenopathy	Epidermoid epithelioma	48 days	No trace of irradiation on skin. *Cure of 6 years' duration*
7	IX-A-75	1932	M 56	L	Suprastructure. Pre-auricular gland	Epidermoid epithelioma	42 days	No trace of irradiation on skin. *Cure of 5 years' duration*
8	IX-A-76	1932	F 30	L	Very extensive. No adenopathy	Epidermoid epithelioma	87 days	Gradual recurrence 3 months after treatment. Second irradiation with non-sterilization and necrosis. Died 18 months after treatment
9	IX-A-78	1933	M 50	L	Very extensive. Carotid gland	Non-epidermoid epithelioma	42 days	Non-sterilization with necrosis. Died 5 months after treatment
10	IX-A-79	1934	M 59	R	Infrastructure. Submaxiliary gland	Epidermoid epithelioma	57 days	Subsequent development of adenopathy. Patient did not return for treatment. Died 6 months after initial treatment

treatment; the other, Case 6, was an extensive lesion with cervical and submaxillary adenopathy and the patient is now cured after 7 years of observation, the communicating orifice between the sinus and buccal cavity having closed spontaneously; the cosmetic result is perfect (Fig. 10). The 3 other cases were tumors localized in the suprastructure. They are all cured, but the cosmetic result is varied, as was noted in the discussion of prolongation of treatment. One patient, Case 2, was treated for 12 days; he developed a corneal ulcer and lost the eye after treatment; 1 year later he developed late radionecrosis of the skin which required 4 years to heal. The cosmetic result is not enviable (Fig. 5). The second patient, Case 4, treated for 18 days, did not lose the eye but the vision diminished to the point of complete loss 2 years after treatment; the skin bears traces of irradiation (Fig. 7). Finally a third patient, Case 7, was treated for 42 days, which permitted adequate ocular protection; he remains cured and has almost perfect vision in the eye of the affected side after 5 years; the skin shows no trace of irradiation (Fig. 9).

CYSTIC CHANGES IN THE ENDOMETRIUM

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THE term "cystic glandular hyperplasia of the endometrium" has come into use since the publication of studies by Schroeder. Numerous authors have contributed articles on this subject. The condition is presumed to occur as a result of a lack of function of the corpus luteum or because of the unopposed action of estrin on the endometrium in the presence of this failure or deficiency of the corpus luteum. It has been said that this condition of the endometrium is frequently associated with the presence of follicular cysts of the ovaries. Shaw affirmed that these cysts are an almost invariable accompaniment of the condition of cystic glandular hyperplasia. Burch and his coworkers said that if progestational changes, those due to the hormone of the corpus luteum, progestin, are present on microscopic examination of the endometrium one is not dealing with endometrial hyperplasia. The final accuracy of this statement must naturally be based on a combined study of the endometrium and the ovaries. Such studies have been made by Shaw and others, and in each series there have occurred instances in which corpora lutea were found. These have been considered to be either immature or old and non-functioning.

The statement is often made that this so called endometrial hyperplasia occurs because of ovarian failure. The terms "ovarian failure" and "ovarian deficiency" often are loosely employed. It is generally agreed that when primary ovarian failure begins the functions of ovulation and formation of corpus luteum are the first to fail. As a result of this failure, production of estrin and the effect of estrin on the endometrium may proceed without the usual inhibition that is imposed by the function of the hormone of the corpus luteum. In this instance one cannot say that failure of the ovary as a whole has occurred for the production of estrin persists and actually may be increased. Such a condition as this may exist for years without the usual manifestations of pituitary hyperfunction that follow failure of production of sufficient estrin to cause normal cyclic pituitary inhibition. The term "ovarian failure" should be qualified. The present state of our knowledge of the disturbances of the physiology of the female genital tract would seem to justify such qualification. In cases in which the term "cystic glandular hyperplasia" has been applied to the condition of the endometrium, one might specify failure or deficiency of corpus luteum function as the case might be. In these cases there is microscopic evidence that failure of the production of estrin and its effect on the endometrium has not occurred. There exists a stage of persistent proliferation as a result of lack of the effect of progestin. Herrell and Broders previously have shown the value of a histologic study and classification of endometrial tissue arrested in its process of regeneration because of a deficiency in the stimuli which control this process.

The microscopic pictures of the cyclic changes that occur in the endometrium in response to the normal ovarian stimulation are recognized generally. The terminology applied to the various phases in this cycle is not universally the same. We believe that the effect of estrin on the endometrium is best denoted by the term "proliferation" and the effect of the hormone of the corpus luteum is best denoted by the term "differentiation." These terms seem best to describe the processes that are evident from microscopic study of the sequence of events that occur in the normal development of the endometrium. Other terms which have been given to the endometrium that show the effect of stimulation by progestin are "secretory," "pregravid" or "progestational." These terms do not seem to correspond in a descriptive sense with the term "proliferative endometrium" that is

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commonly applied to the histological picture during the estrogenic stimulation in the first half of the normal menstrual cycle. The terms that are applied to the histological picture of the endometrium when the normal sequence of the effects of estrin and progestin have been interfered with are admitted by many writers to be inadequate and not entirely satisfactory. Thus the fully developed picture of the endometrium referred to as "cystic glandular hyperplasia" represents complete failure of the function of the hormone of the corpus luteum, probably for a considerable time and to a considerable degree. The microscopic evidence of persistent proliferation or so called hyperplasia varies greatly in specimens of this type of endometrium. This variation probably depends on the amount and duration of stimulation from an unopposed effect of estrin. There is microscopic evidence that intermediate stages of corpus luteum failure exist in which evidence of differentiation of the endometrium, due to the action of the hormone of the corpus luteum, is incomplete. The history of spontaneous remissions of atypical bleeding and spontaneous recurrence, which is not uncommon among patients who have these degrees of hormonal deficiency, suggests that this is true. The varied symptoms, such as atypical bleeding, amenorrhea, and the occurrence of cystic endometrium among women who have normal menstrual periods, further suggest that there are degrees of loss of function of corpus luteum which may eventually lead to a persistent proliferative phase of the endometrium with cystic degeneration (cystic glandular hyperplasia).

Microscopic examination has been made of 278 specimens previously described (3). In 28 of these specimens cystic changes were found. The endometriums in which the cystic changes occurred represented all phases of the endometrial cycle, early and late proliferative and early and late differentiative, including the earliest evidence of stimulation with estrin and the complete differentiation which results from the action of progestin. In the 28 cases in which cystic changes were present in the endometrium, the phases of the menstrual cycle were as follows: early proliferative phase in 5 cases, late proliferative phase in 8 cases, early differentiative phase in 9 cases, and late differentiative phase in 6 cases.

In the 5 cases in which the endometrium was in the early proliferative phase, the specimens were removed 17, 22, 59, 90, and 199 days, respectively, after the first of the preceding uterine bleeding. None of the patients in these 5 cases gave a history of normal menstruation; 2 had a bleeding dysfunction (menorrhagia and metrorrhagia); 2 had irregular scanty periods and 1 had had amenorrhea for more than 6 months. Two patients in this group complained of inability to become pregnant. Two patients gave a history of removal of a cystic ovary prior to their visit to the clinic. None gave evidence of cystic ovaries at the time of examination.

The specimens of endometrium which were in the late proliferative phase of the menstrual cycle were removed on the 17th, 18th, 18th, 20th, 20th, 21st, 22nd, and 23rd day, respectively, after the first day of the last uterine bleeding. Four of the patients in these 8 cases gave a history of normal menstruation; 4 gave a history of menorrhagia and metrorrhagia; 5 complained of sterility; 1 had had a cystic ovary removed prior to her visit to the clinic, and the remaining ovary measured 3 by 5 centimeters at the time of her examination at the clinic. In 3 of these cases the basal metabolic rates were lower than normal: in 2 cases the basal metabolic rate was -17; in the other case it was -15. The menstrual histories were normal in these 3 cases.

In the 9 cases in which the endometrium was in the early differentiative phase of the menstrual cycle, 4 patients gave a history of a normal menstruation and 3 gave a history of bleeding dysfunction. Seven complained of sterility. Three had ovarian cysts at the time of examination and 1 had had a cystic ovary removed prior to her visit to the clinic.

In 4 of the cases in which the endometrium was in the late differentiative phase of the menstrual cycle the menstrual history was normal and in 2 cases the menstrual flow was scant in amount but the interval between periods was 28 days. Two patients in this group were found to have cystic ovaries. None of the patients in this group had bleeding dysfunction and all complained of sterility.

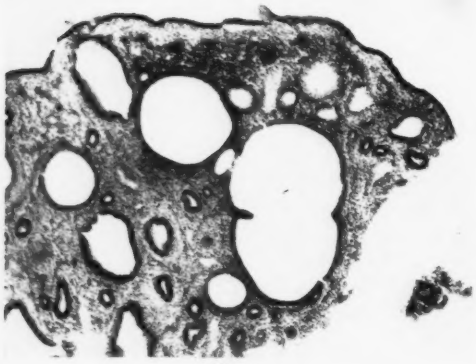

Fig. 1.

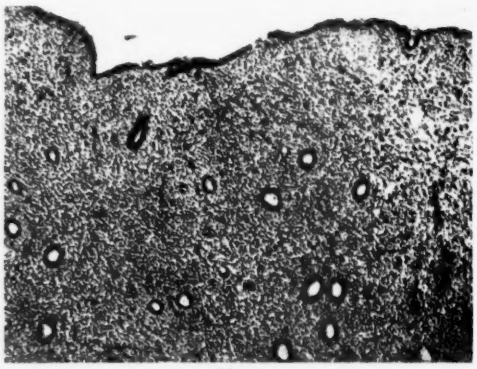

Fig. 2.

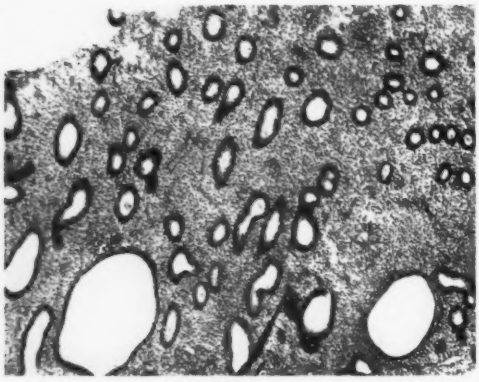

Fig. 3.

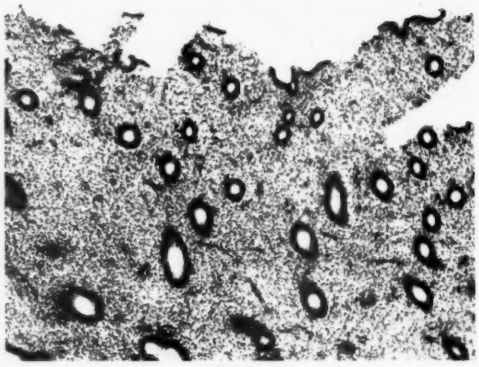

Fig. 4.

Fig. 1. Persistent early proliferative phase of the menstrual cycle in a cystic endometrium. The normal glands in this section are identical with those shown in Figure 2; they are small straight tubular glands lined with low epithelium. This endometrium differs from normal endometrium only by the presence of several large cysts which are lined with flat epithelium. There is no actual increase, however, in the total number of glandular elements (previously called hypertrophied or hyperplastic endometrium). The average thickness of this endometrium is 1 millimeter. This specimen was stained with hematoxylin and eosin (×37).

Fig. 2. Early proliferative phase of the menstrual cycle in normal endometrium. This specimen was obtained on the fifth day of the normal menstrual cycle. The glands are of the straight tubular type. They are of small caliber and are lined with low proliferative epithelium. The average number of longitudinal glands per low power field is 3. The average thickness of this endometrium is 1 millimeter. This specimen was stained with hematoxylin and eosin (×37).

Fig. 3. Persistent late proliferative phase of the menstrual cycle in a cystic endometrium. The average thickness of this endometrium is approximately 2 millimeters. The glands are nearly identical with those found in the same phase of the cycle in a normal endometrium (Fig. 4) except that they are larger and are still of the straight tubular type. The average number of longitudinal glands per low power field is 6. This endometrium is approximately 2 millimeters thick. The only abnormality is the cystic appearance but this is not histological evidence of true hyperplasia. Specimen was stained with hematoxylin and eosin (×37).

Fig. 4. Late proliferative phase of the menstrual cycle in normal endometrium. This endometrium is approximately 2 millimeters thick. The average number of longitudinal glands per low power field is 6. The glands are still of the straight tubular type but they are increased in number. The glands are lined with proliferative epithelium. This type of endometrium is found from the 8th to the 14th day of the menstrual cycle. Specimen was stained with hematoxylin and eosin (×37).

REPORT OF CASES

CASE 1. A woman, aged 30 years, came to the clinic because of menorrhagia and metrorrhagia. The first menstrual period had occurred when she was 14 years of age. The interval had been 28 days and the duration had been 7 days until the 2 years before she came to the clinic. Since that time the interval had varied from 2 to 6 weeks and the menstrual flow

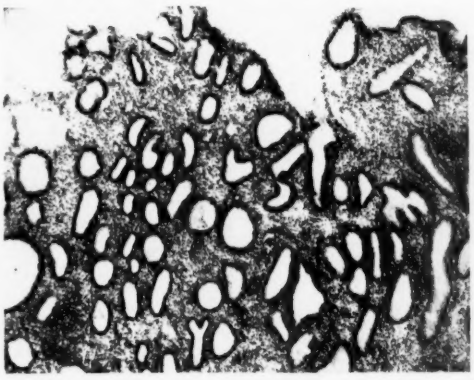

Fig. 5, left. Persistent early differentiative phase of the menstrual cycle in a cystic endometrium. The longitudinal glands in this specimen are characteristic of the early differentiative phase. The glands are lined with columnar epithelium, and the glands also show convolutions which are normal (Fig. 6) for the early differentiative phase, that is, the 15th to 21st day of the cycle. The average number of longitudinal glands per low power field is 6 to 7. The endometrium shown differs from the normal only by the presence of cystic areas lined by a flat non-functioning epithelium. Some effect of the corpus luteum hormone is shown in the endometrium. However, the absence of complete differentiation in the presence of cysts is indicative of partial failure. Specimen was stained with hematoxylin and eosin (×37).

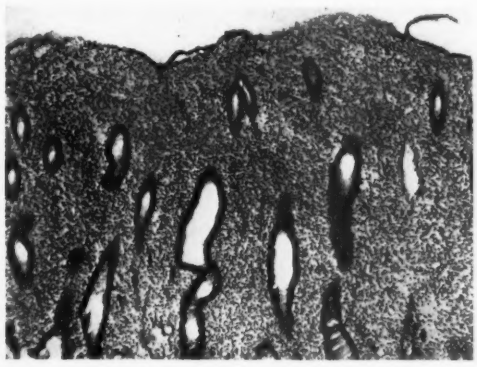

Fig. 6. Early differentiative phase of the menstrual cycle in a normal endometrium. The specimen was obtained for biopsy on the 15th day of a normal menstrual cycle. This endometrium shows beginning differentiation. There are convolutions of the longitudinal glands and a transition to a columnar or differentiative type of cell. The endometrium is approximately 2.5 to 3 millimeters thick. The average number of longitudinal glands per low power field is 6 to 7. These are evidences of a beginning effect of the corpus luteum hormone. Specimen was stained with hematoxylin and eosin (×37).

had lasted from 2 to 3 weeks. In addition, slight spotting had been noted on several occasions. Twice in the 6 months preceding her visit to the clinic the menstrual flow had lasted for nearly 4 weeks. Dilatation and curettage had been performed 1 year before we saw her at the clinic, but no evidence of malignant change had been found by microscopic examination. The basal metabolic rate was 0. Biopsy of the endometrium, which was performed 22 days after the first day of the last uterine bleeding, revealed a cystic endometrium which was in an early proliferative phase of the menstrual cycle. The tissue is shown in Figure 1 and the normal appearance of early proliferation is shown in Figure 2.

Case 2. A woman, aged 27 years, came to the clinic because of irregular and prolonged menstrual flow. She was not married. The first menstrual period had occurred when she was 13 years of age. There always had been a great variation in interval between the menses. The menstruation always had been very profuse. Dilatation and curettage had been performed 3 times but this had not produced any relief. General physical examination and pelvic examination did not reveal any abnormality. The basal metabolic rate was −7. The estrin content of the urine on the 23rd day of a 25 day menstrual cycle was 11 rat units per liter of urine. A test for normal amounts of prolan in the urine gave negative results on the 24th day of the same cycle. Biopsy of the endometrium was performed on the 23rd day of a 25 day menstrual cycle. Microscopic examination of the tissue revealed a persistent late proliferative phase of the endometrium which was associated with cystic changes. This tissue is shown in Figure 3 and the normal appearance of the late proliferative phase of the menstrual cycle is shown in Figure 4.

Case 3. A woman, aged 23 years, came to the clinic because of primary infertility. She had been married 4 years. The menses, which first had occurred at the age of 13 years, always had been irregular and prolonged. The amount of menstrual flow per day had, however, not been excessive. Examination revealed that the left ovary was about 4 by 5 centimeters in size. The basal metabolic rate was +4. The estrin content in the urine on the 30th day of the menstrual cycle was 40 rat units per liter. An estimation of the amount of prolan in the urine on the 31st day following the last menstrual period failed to reveal any evidence of this hormone in the urine. Transuterine insufflation of the fallopian tubes was performed and the kymographic tracing showed a maximal pressure of 170 millimeters of mercury and a minimal pressure of 120 millimeters of mercury. The uterine cramp which was produced by this procedure and the high pressure necessary to force gas through the fallopian tubes suggested the possibility of muscular resistance. Biopsy of the endometrium was done on the 32nd day of a 34 day menstrual cycle. Microscopic examination of the tissue which was removed revealed an endometrium in the persistent early differentiative phase of the

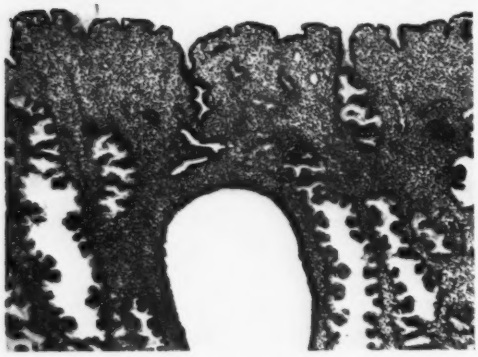

Fig. 7, left. Late differentiative phase of the menstrual cycle in a cystic endometrium. This specimen shows complete differentiation. There are 6 to 7 longitudinal glands to the low power field, but differentiation is complete. The abnormal feature of this endometrium is the presence of cystic areas existing in an endometrium which histologically shows nearly complete effect of the hormone of the corpus luteum. Specimen was stained with hematoxylin and eosin (×37).

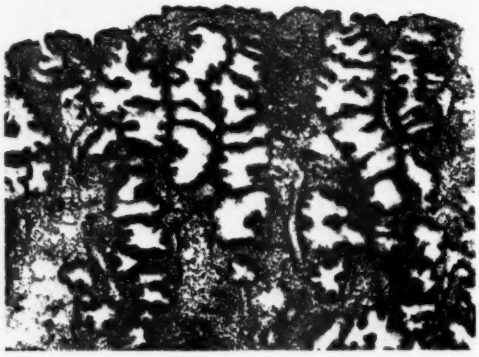

Fig. 8. Late differentiative phase of the menstrual cycle in a normal endometrium. Specimen obtained on the 25th day of a normal menstrual cycle. The average number of longitudinal glands remains 6 to 7 per low power field. The glands are twisted on the longitudinal axis giving in cross-section a sea-shell appearance. The epithelium lining the glands is fully differentiated. This effect is due to complete action of the hormone of the corpus luteum on the endometrium. The endometrium is approximately 4 millimeters thick. Specimen was stained with hematoxylin and eosin (×37).

cycle, and cystic changes. This tissue is shown in Figure 5 and the normal early differentiative phase of the menstrual cycle is shown in Figure 6.

CASE 4. A woman, aged 26 years, came to the clinic because of primary infertility. She had been married 3 years. The menses first had appeared when she was 15 years of age. The interval between the menstrual periods always had been 28 days, and the duration had been 4 to 5 days. For several months before the patient came to the clinic there had been some decrease in the amount of menstrual flow. Examination revealed that the right ovary was about 3 times the normal size. The basal metabolic rate was −4. On the 26th day of the menstrual cycle the estrin content of the urine was found to be 10 rat units per liter. The amount is within normal limits for this phase of the menstrual cycle. The urine was tested for an excessive amount of prolan on the 27th day of the menstrual cycle but the result was negative. Transuterine insufflation of the fallopian tubes revealed a normal kymographic tracing and a maximal pressure of 65 millimeters of mercury. Biopsy of the endometrium was performed on the 26th day of a 28 day menstrual cycle. The tissue was found to be of a late differentiative phase of the menstrual cycle and cystic changes were noted. This tissue is shown in Figure 7 and the normal differentiative phase of the menstrual cycle is shown in Figure 8.

COMMENT

Microscopic examination of 28 specimens of endometrium revealed that cystic changes occurred in all phases of the menstrual cycle. In those endometriums in which cystic changes occur in the proliferative phase there is often an accompanying proliferation, so called hyperplasia, of a greater degree than occurs normally. Thus, a polypoid endometrium is usually increased in thickness, although the microscopic picture of the proliferation remains the same. As the differentiative phase appears and increases, this proliferation is less and less noticeable but the cystic changes persist. These microscopic findings seem to correlate with the clinical history. Atypical bleeding was not present in any case in which a well differentiated endometrium was associated with cystic changes. Those tissues in which cystic changes were found in the early differentiative phase were not infrequently associated with atypical uterine bleeding. In cases in which a cystic endometrium was in the late proliferative phase of the menstrual cycle, atypical bleeding was more frequently present. The essential difference in these specimens of the endometrium is the degree of differentiation which must exist because of a difference in the activity of the hormone of the corpus luteum. It has been said that the function of the corpus luteum is on an all or none basis. There is microscopic evi-

dence to the contrary. Cystic changes are very common in the endometriums of women at the beginning of the menopause, when the first phase of ovarian failure is commencing. Ovarian failure is essentially the same among younger women and should be accompanied by the same microscopic appearance of the endometrium. The corpus luteum is a gland of internal secretion. No other of the so called endocrine glands has an all or none reaction so far as function is concerned. An all or none response is certainly not true of the graafian follicle because all degrees of proliferation can be observed microscopically.

SUMMARY

Microscopic study of 278 specimens of endometrium removed with a biopsy curette revealed that in 28 of these specimens cystic changes had occurred. These tissues represented all phases of the menstrual cycle from the early proliferative phase to the late differentiation. This cystic change is believed to be the result of failure or deficiency of the function of the corpus luteum. The amount of proliferation is dependent on how complete or persistent this failure or deficiency has been.

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PATHOGENESIS OF ANAL FISSURE AND IMPLICATIONS AS TO TREATMENT

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AN anal fissure is a lesion of comparatively minor pathological import. But from the clinical point of view, its frequency, its common misdiagnosis, its often inadequate management, with the resultant sum total of extreme discomfort and incessant nagging pain—all combine to make it one of the most important anal lesions. To this every proctologist will attest. To him the typical history of neglect, or ineffectual treatment, over weeks and months —of ointments and applications of every kind and description, of brutal dilatations, and of various injections and surgery—is a matter of almost daily experience. And the physician who finally secures relief for the patient is indeed the recipient of the latter's genuine gratitude.

Heretofore there has been no fully adequate nor complete statement of pathogenesis concerning this common lesion. There has resulted, as always under such circumstances, a babel of therapeutic suggestions, with assurance granted to none that his efforts at cure were along logical and scientific principles. Apparently divergent methods of treatment, presupposing also divergent concepts of pathogenesis, or even without any such concept, have occasioned equally satisfactory reports, and as positive denunciation. Nearly all procedures have, on analysis, combined a variety of elements, and no one, by a sound basis of pathogenesis, could say which were the effective, and which the inert, components. The pragmatic test of cure has been misleading both because of these multiple elements and also because of glaring mistakes in criteria of cure.

We wish here to present for the first time a completely adequate conception of pathogenesis which fits in with all the known facts at our disposal, which explains the favorable impressions of apparently divergent methods of treatment, and crystallizes what has been the common active element, the recognition of which alone can insure more intelligent treatment. We wish to point out also the mentioned mistakes in criteria of cure, not heretofore discussed.

First, however, a passing word as to diagnosis. All patients with this lesion complain of acute and real anal pain; a history of a few days of such pain is commonly caused by only 3 lesions, viz., acute thrombosed hemorrhoids, acute abscesses, and anal fissures. Differential diagnosis usually involves then only these 3 conditions whenever a patient presents himself with acute anal pain. If symptoms have continued somewhat longer (and this is more commonly the case), past the time when an abscess would have ruptured, and visual examination reveals no thrombosed hemorrhoids, one can be almost sure that an anal fissure is present. And let no one, with any sympathy for human suffering, undertake exhaustive corroborative examination without at least surface anesthesia!

A good start had been achieved toward a firm pathological basis on which to build a rational therapeutic structure with the observation that these fissures are for the most part found directly posterior in the anal canal, occasionally directly anterior, and only very uncommonly elsewhere around the circumference. It was logical to assume, therefore, that whatever peculiar factor of any nature, anatomical or pathological, or both, could be found commonly posteriorly, and to a less extent anteriorly, would provide a satisfactory point of departure. Such a factor was found in the Y shaped divergence of certain of the external sphincter fibers in their course to attach to the coccyx, and, to a less extent anteriorly.

And it should be emphasized, on the other hand, that all pathological lesions, such as crypts, hemorrhoids, hypertrophied papillæ, and varicosities, which theoretically might

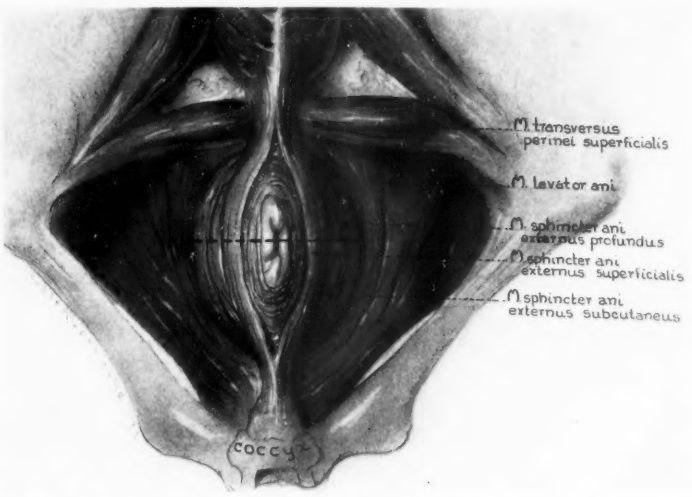

Fig. 1. Sphincter muscles of the anus from below. Vertical levels of the various parts are shown in Figure 2. The transverse dotted line is for the purpose of identifying section represented by models. Notice that the subcutaneous and deep portions of the external sphincter are arranged in a circle, while only the superficial portion diverges to anterior and posterior attachments. (After Milligan and Morgan in *The Lancet*.)

cause fissures, are very noticeably inconspicuous directly in the posterior and anterior commissures. It is well known that these pathological entities occur most constantly and invariably at 5, 7, and 11 (referring to the face of a clock) and *not* at 6 and 12 where fissures occur. If fissures are caused by underlying hemorrhoids and varicosities, why are the former *rarely* found where the latter are *constantly* situated! Or if, as is also commonly stated, a fissure is the result of a torn crypt, why are not *other* crypts, commonly found elsewhere around the circumference, also torn! If that be the complete explanation, why are they found torn just anteriorly and posteriorly! No, these explanations are simply inadequate. It is not denied that these other lesions have bearing, and no treatment for fissure should be considered adequate which does not include appropriate treatment for them, but their rôle is not major.

It is to the peculiar anatomical features, then, rather than to possible concomitant pathological entities, that we must logically turn for further consideration as regards the pathogenesis of anal fissures. The explanation by the Y arrangement of the muscle fibers was put forward by Lockhart-Mummery, as quoted by Gabriel, and is a commonly accepted one, the overlying tissues being assertedly least supported at the commissures by such arrangement. But no treatment ever suggested has attempted to correct this underlying cause, if such it be, or achieved such correction, an obviously illogical state of affairs!

One important fact was, and has been, overlooked, in connection with this explanation, and this failure led to loss of the scent and to the pathological groping and resultant divergent therapeutic opinion. Such explanation would inevitably presuppose the resultant fissure to occur directly between the crotches of the Y, as shown by the circle in Figures 2, 4, and 5. If one will examine these cases with this point particularly in mind, disturbing tissue relations as little as possible by means of utmost gentleness, he will find that these fissures do *not* occur *above* the anal intermuscular septum on the tissues overlying the crotch but further caudad, as shown by the square in the same figures, on the surface of

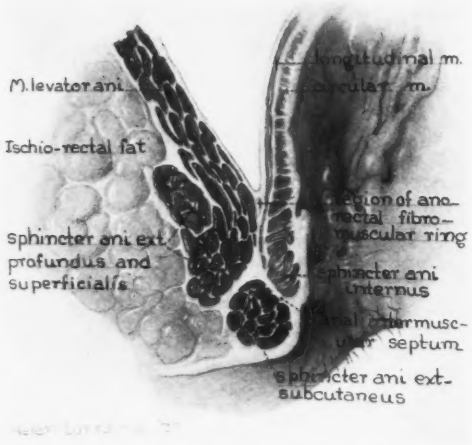

Fig. 2. Vertical section of anal canal. Notice that the subcutaneous portion of the external sphincter is on the same vertical plane with the internal sphincter, separated from it by the anal intermuscular septum, a landmark readily identified in the living by palpation; the deep and superficial portions of the external sphincter, on the other hand, surround the internal sphincter, enclosing and supporting it. Black circle and square have been added and are explained in text. (After Milligan and Morgan in *The Lancet*.)

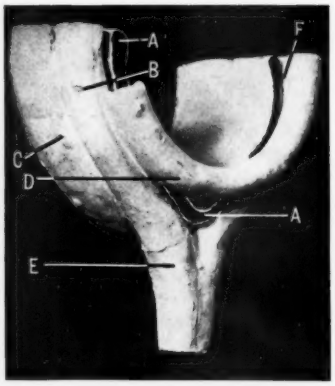

Fig. 3. Model of the sphincter muscles of the anus, representing section below dotted line in Figure 1. Levator ani muscle is not included. Model represents muscles in dilated state. *A*, lower border of internal sphincter. A small piece of the subcutaneous portion of the external sphincter has been cut away at the upper left to show how this portion and the internal sphincter are on the same vertical plane. *B*, superficial portion of the external sphincter with diverging fibers *E* attaching to coccyx. *C*, deep portion of external sphincter composed entirely of circular fibers. *D*, subcutaneous portion of external sphincter, consisting entirely of circular fibers which do not surround and support the internal sphincter, as do the superficial and deep portions, but is on the same vertical plane with it, and separated from it by the anal intermuscular septum *F*.

the *subcutaneous portion* of the external sphincter, the fibers of which do not attach to the coccyx, but run circularly all the way around the anus. These fissures occur so near the outlet that they may usually be seen with but very slight, indeed sometimes without any, parting of the anal folds or outward sliding of the skin. Such would not be the case if the fissures occurred higher up on the surface of the internal sphincter which overlies the crotch of the superficial portion of the external sphincter (Fig. 4). Examination under anesthesia reveals that the relation of the fissure to the anal intermuscular septum and subcutaneous portion of the external sphincter can be corroborated by palpation with the finger, for these latter are easily recognizable landmarks.

And yet we believe it impossible to get away from the fact of the Y shaped diverging fibers as an etiological factor. For further consideration, as also for full appreciation of the discussion to this point, a detailed knowledge of anal anatomy is essential. The recent paper of Milligan and Morgan is the best practical exposition on this subject of which we know and in our opinion should be thoroughly mastered by all who perform rectal surgery. It is only possible to point out within the limits of this paper that the external sphincter is in reality composed of 3 distinct portions, viz., the deep, the superficial, and the subcutaneous portions (all figures). The deep and superficial portions surround the internal sphincter (which is but the slightly thickened termination of the circular coat of the bowel) like a band, the deep portion merging at its upper border with the levator ani. The deep and subcutaneous portions are composed of circular fibers only, while *only the superficial portion has Y shaped fibers posteriorly* (and to a less extent anteriorly), with attachment to the coccyx. Also to be especially noted is that the subcutaneous portion does not enclose the internal sphincter, as do the other portions, but is caudad to it, on the same longitudinal plane with it, and

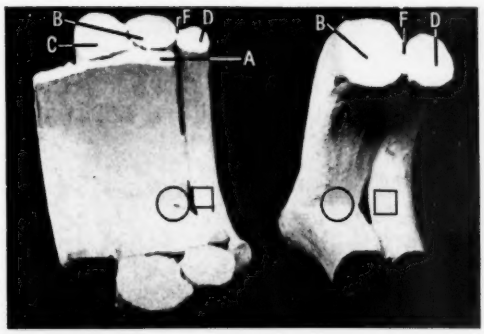

Fig. 4. On left is model shown in Figure 3, looking down on it from above. On right are just segments of the subcutaneous and superficial portions of the external sphincter in same relative position, showing diverging fibers of latter. If these diverging fibers were the sole cause of fissure, the latter would be situated as represented by the circle, which occupies the same relative position in both models. Fissures do *not* occur here, however, but are found rather at position marked by the square. Letters represent the same structures as have been described in Figure 3.

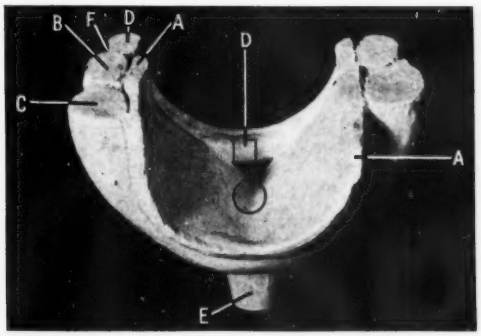

Fig. 5. Same model as Figure 3, representing here a view of the anal canal looking from within out, with muscles in dilated state. The formation of a posterior bar (and to a less extent an anterior bar) by the comparatively weak and comparatively unsupported subcutaneous portion of the external sphincter is plainly shown, and reveals the necessity of including the severance of this bar as a part of the procedure in the treatment of anal fissure. The letters represent the same structures as have been described in Figure 3.

separated from it by the anal intermuscular septum.

Now then, why are fissures found on the surface of the subcutaneous portion? The explanation is found on viewing our models illustrated, and from them hypothecating the behavior of the component elements on dilatation of the anus as during the passage of feces. The situation is shown in Figure 3. The bowel wall including the internal sphincter is well supported at the upper limit of the anal canal by the surrounding deep portion of the external sphincter, strongly supported in turn by the levator ani; further down it is well supported by the surrounding superficial portion of the external sphincter; together, the internal sphincter and surrounding superficial portion of the external sphincter, together with intervening tissue, form a strong support, and posteriorly the elements inside the crotch of the external sphincter follow the shape of the latter as shown. The subcutaneous portion of the external sphincter, now, besides being the smallest of the 3 components of the external sphincter, stands by itself, as can be seen, unaugmented by internal sphincter and other elements within, and with no attachments to the coccyx posteriorly. *It must therefore swing across the crotch as shown—the weakest part of the whole anal ring.*

Now let us view the situation from within the rectum, looking outward through the anal canal (Fig. 5). The relatively weak and unsupported subcutaneous external sphincter is plainly seen, stretched across like a bar. And both because of its comparative weakness and its uniquely exposed and unsupported position, it constitutes, together with its overlying mucous membrane, the most vulnerable point to injury, during defecation, of the whole anal canal.

If one doubt the existence of this bar, let him examine the anus with this in mind, following the landmarks suggested by Milligan and Morgan. He will feel plainly the anal intermuscular septum, and caudad to it the subcutaneous portion of the external sphincter—all the way around, but more plainly and distinguishably directly posterior, and particularly if the anal canal be put on stretch while withdrawing opposed examining fingers. We have repeatedly asked inexperienced internes assisting us in operating upon these patients to palpate the anal canal on the ball of the flexed forefinger, drawing it slowly from within out, and to compare sensations obtained in the commissures and lateral quad-

rants. With no coaching or suggestions whatsoever on our part the posterior subcutaneous bar beneath the fissure is invariably noted except in cases in which particularly profound relaxation is obtained by the anesthetic. Even in these latter cases, with the assistance of an indefinite suggestion of such a bar as possibly being present in one of the quadrants, its presence is usually correctly determined posteriorly.

The implications as to treatment are obvious. Severance of the muscle bar to conform with the Y shape of the more cephalad superficial portion of the external sphincter must theoretically comprise the essential element of treatment, with a light pack of vaseline gauze laid in the wound in the direction of the anal canal for several days to prevent healing of the ends into the old position.

The validity of these theoretical considerations has received practical proof in my own experience of several hundred cases. We have used exclusively the wedge shaped resection of the ulcer described by Gabriel, with the broad base on the outside of the canal including healthy tissue. This base has been dissected rather deeply, its greater width and depth thus affording opportunity for the wound to heal first on the inside. At first the muscle was not severed and recurrence of the fissure was so common that we were thus led to the review and study of the situation with this communication as the result. Since severing of the muscle bar, recurrence has not been a factor, even with a much less radical dissection than advocated by Gabriel. The procedure is not recommended to those who are unable to recognize, at least approximately, the limits of the subcutaneous portion of the external sphincter. In all of our experience we have never had a single untoward result from severance of these fibers, but we do not share a commonly expressed confidence in the innocuousness of unlimited posterior proctotomy.

Other proctologists of experience, such as Buie (5), for example, have expressed their conviction on the importance of severing muscle fibers, although no accurate description of just what amount should be severed is found. Others have opposed this particular step, while some have mentioned it as rather optional, for heretofore the procedure has been entirely empirical and there has been lacking the rational correlation of an adequate conception of pathogenesis with what was accomplished by severance of the muscle, such complete concept being necessary to make the position impregnable. For example, it had been held that such severance "put the muscles at rest" and thus gave chance for healing. But wounds following hemorrhoidectomy and other anal surgery do not require the muscles "being put at rest" to heal satisfactorily, nor in the nature of things could the sphincter mechanism *be* put at rest without its complete severance, and resultant incontinence. It is small wonder that the importance of this element of procedure has failed of the universal recognition which this study demonstrates to be deserved.

Furthermore, we have already alluded to the possibility of fallacious criteria of cure as having been a factor in failure to achieve universally accepted treatment. In this connection we wish to point out that by resection of the fissure alone one can and does very frequently obtain symptomatic relief without actual healing of the fissure. This is because of effective interruption of nerve fibers by the resection of tissue and its replacement by insensitive scar tissue. Indeed, several of our patients in the past, who failed to return for final examination as directed, since they felt so well, returned later with fistulas which had originated in unhealed or recurrent fissures.

Another point to which I wish to call attention is that healing, even though corroborated by vision, is not a sufficient criterion of satisfactory cure. These fissures frequently heal without *any* treatment. Indeed, a history of alternating periods of healing and recurrence is typical and characteristic. In other words the factor of *recurrence* and not of healing becomes the real criterion of successful management. *Permanent* healing, corroborated by repeated *visual* examination, must constitute the only adequate criteria of the efficacy of any treatment of anal fissure. It can readily be appreciated how failure to observe these criteria has, in the past, added considerably to confusion.

Dilatation of the anus has been commonly advocated as treatment of anal fissure. Repeated dilatations in combination with anesthetic oily solutions is a recent suggestion of Daniels. Here too, the explanation of "rest" has constituted the theoretical background. A more logical explanation is a stretching, first, and most markedly, and thus obliteration of, the weak and prominent bar. There are valid arguments against the method.

We should like to dwell at length on the many misconceptions which are encountered in the literature and are common in practice; but it would take us too far afield. They can in large measure be forgiven, because heretofore, as stated, no entirely adequate thesis of pathogenesis or criteria of cure has been developed and universally accepted. One word, however, concerning a therapeutic measure which has attained extended credence but which fits in with no rational pathological basis, viz., the injection of oily anesthetic solutions beneath the ulcer. By the relief of pain, this is said to relieve spasm of the sphincter long enough to allow the fissure to heal.

Now either the pain of the fissure inaugurates the spasm of the muscle or else the spasm inaugurates the fissure. True, it is possible to have some element of a vicious circle, but one or the other must be the primary and dominant factor. If the fissure be first, and such is logical, then injection of the anesthetic will, by relief of pain, relieve the spasm—just as morphine relieves the rectus spasm of acute appendicitis. But what theoretically conceivable pathological cause of the fissure could thereby be affected, any more than the appendix is removed by the morphine! If, on the other hand, the spasm of the muscle be the primary lesion and the cause of the fissure, then too, relief will continue only until the anesthetic wears off; the pathological basis of the spasm remains.

This paper is not intended to serve as a complete guide to the treatment of anal fissure. At best, there is much in experience with these lesions which printed word can scarcely convey. One learns, for example, how necessary is constant postoperative supervision of the wound to prevent bridging instead of healing from the bottom; how carelessness in this respect can in a few days entirely nullify one's most perfect operative efforts; how the base of the wound must be prevented from healing before the apex inside; that scar tissue and other pathological lesions must be removed; and that the edges of the wound must be carefully trimmed. These details and others must forego expression here, for we wished at this time only to clarify by our observations if possible, and emphasize, more general principles.

SUMMARY

Lack of an adequate concept of pathogenesis and errors in criteria of cure have retarded agreement on principles of treatment of anal fissure.

Severance of an indefinite portion of the external sphincter has been a disputed point in the treatment of anal fissure, and evidence submitted has been largely empirical. An adequate concept of pathogenesis is presented which lends firm support to the affirmative view, and accurately defines the portion of the sphincter to be severed.

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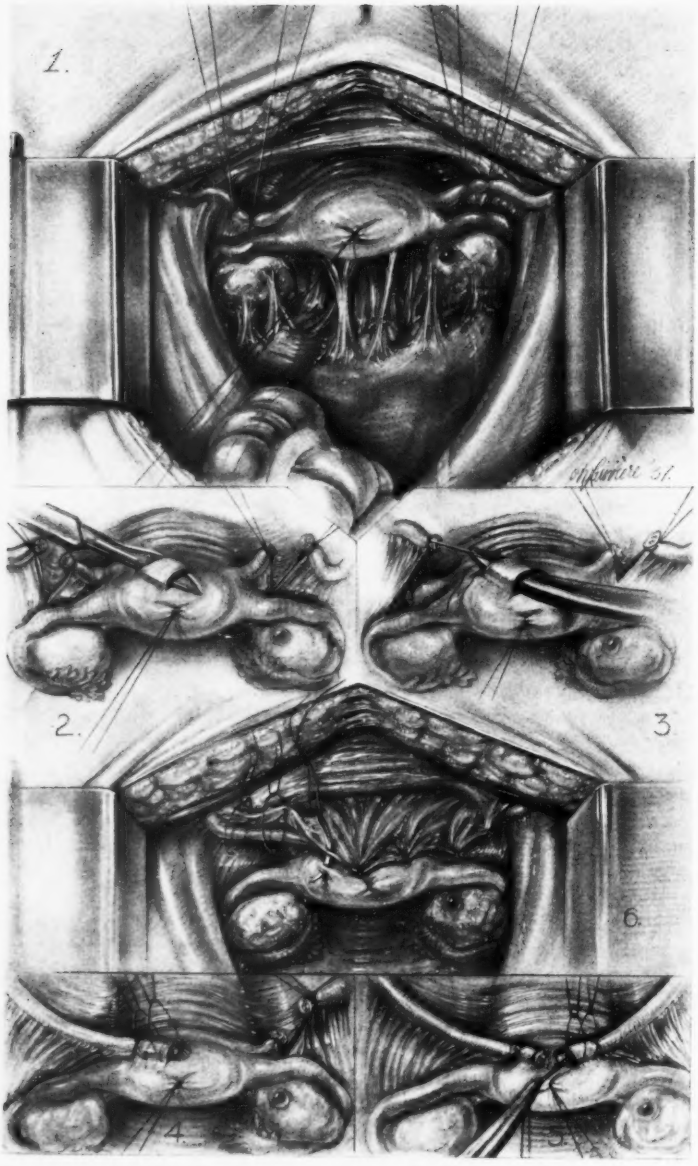

The "Tunnel" Method for Correction of Uterine Retroversion.—J. Lyle Cameron.

CLINICAL SURGERY

FROM THE GYNECOLOGICAL SERVICE, ROYAL WATERLOO HOSPITAL, LONDON

THE "TUNNEL" METHOD FOR CORRECTION OF UTERINE RETROVERSION

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RETROVERSION of the uterus necessitating some form of operative intervention for relief of symptoms is a very common condition and one often encountered during the performance of lower abdominal operations such as appendicectomy. It is, therefore, advantageous for the general surgeon to be familiar with a simple method of dealing with cases of retroversion, and one which can be depended upon to yield satisfactory results.

The operation for correction of retroversion of the uterus about to be described is one which I have employed with uniform success for some years.

With slight modifications in technique the procedure is similar to that devised by Professor van Rooy of Amsterdam whose excellent work I have been privileged to witness.

The *indication* for its employment is retroversion of the uterus associated with backache, dysmenorrhea, dyspareunia, pelvic pain, or a feeling of weight in the pelvis when the patient is standing or walking.

Its special *advantages* are that the fundus of the uterus is tilted forward without lifting the uterus out of the small pelvis which is its normal situation and where mechanical factors may be such as to assist the processes associated with conception. Furthermore, as van Rooy pointed out, the fallopian tubes are neither kinked nor bent as is usually the case when forward suspension of the uterus is effected by operations which entail shortening or tightening of the round ligaments. This bending of the fallopian tubes was thought by van Rooy to be a potent cause of the sterility which frequently follows these round ligament operations.

Contra-indications to its use are acute or subacute salpingitis, and conditions which firmly fix the uterus in a retroverted position such as extensive inflammatory adhesions or occasionally dense fibrosis associated with endometriosis, especially when the fallopian tubes or ovaries are irreparably damaged and sterility is inevitable. In such circumstances a firmer and stronger fixation of the uterus is imperative.

Procedure. Preparation for abdominal operation is carried out in the usual manner. With the patient in the Trendelenburg position a skin incision 4 to 5 inches long is made in the midline below the umbilicus and with the lower end terminating about 1 inch above the pelvic brim. The opening in the aponeurosis and parietal peritoneum is carried well down to the upper border of the symphysis pubis. The wound edges, being covered with mackintosh sheeting and thin towels, are separated with a self-retaining re-

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Fig. 1. The abdomen having been opened and the wound edges retracted, the uterus is drawn upward with a traction stitch through the fundus. Thin strands and tenuous veils of fibrous adhesions are rendered taut and easily divided. Two stitches are passed around each round ligament, one ¼ inch and one ½ inch from the side of the uterus.

Fig. 2. The round ligaments on each side have been divided between the pairs of stitches, and an oblique tunnel is now made with a small scalpel or a pair of pointed scissors through the musculature of the front of the uterine body.

Fig. 3. A pair of forceps is passed through the tunnel gripping the stitch on the distal portion of the round ligament which is to be drawn through the tunnel to the required distance.

Fig. 4. The distal portion of the round ligament is secured in the tunnel by two stitches, the redundant portion having been removed.

Fig. 5. The round ligament on the opposite side is drawn through the tunnel similar to that previously made and secured in place with stitches.

Fig. 6. A fold of peritoneum along the line of its loose reflection from the front of the uterus on to the bladder has now been lifted up and stitched into place so as to cover the tunnels and all needle punctures in the front of the uterus. No opening is left through which bowel or omentum may obtrude.

tractor, and the towels and mackintosh sheets are then well drawn into the upper and lower angles of the incision. Intestine, omentum, and sigmoid colon are gently lifted up out of the pelvis and allowed to fall above the sacral promontory. The abdominal cavity is excluded with a large soft turkish towel rung out of warm saline. When careful exploration has been made, the condition of the pelvic organs has been ascertained, and thin strands or tenuous veils of fibrous adhesions have been divided, the uterus is drawn forward and upward with a traction stitch through the front of the fundus (Fig. 1). Two stitches are passed around each round ligament, one about ¼ inch and the other about ½ inch from the uterus (Fig. 1), the round ligament between each pair of stitches then being divided (Fig. 2). Any bleeding vessels are secured with clamps and ligatures or with small mattress stitches of fine catgut as the distal portion of each round ligament is freed for about 1 inch (Fig. 2). A tunnel about 1¼ inches long is now made through the musculature of the front of the corpus uteri with a small scalpel or pair of pointed scissors (Fig. 2). The direction of the tunnel is estimated by pulling the uterus into the desired position and drawing the freed distal end of the fallopian tube into the situation which it will ultimately occupy. The outer end of the tunnel is made medially to the uterine vessels and the inner end emerges on the front of the uterus about ¼ inch lateral to the midline and about ½ inch below the highest point of the fundus. A pair of forceps is now passed through this tunnel, securing the stitch on the distal portion of the round ligament which is drawn through the tunnel (Fig. 3) and secured with two, or if found necessary three, interrupted stitches of chromicized catgut (Fig. 4).

This process is now repeated on the opposite side (Fig. 5).

Each round ligament is drawn through the corresponding tunnel sufficiently far to obtain the desired degree of forward version of the uterus, and the redundant portion is removed.

Hemorrhage from needle punctures is arrested with fine mattress stitches of chromicized catgut on an eyeless intestinal needle.

The area in front of the uterus where the tunnels have been made and which has been pierced by many stitches is now covered to prevent the possibility of bowel or omentum becoming adherent. A fold of the peritoneum along the line of its loose reflection from the front of the lower uterine segment on to the bladder is lifted up and sutured to the front of the fundus uteri with several interrupted catgut stitches (Fig. 6) which secure it in place and occlude any opening through which a coil of bowel or a tongue of omentum might obtrude. In securing this fold of peritoneum care must be taken to avoid puncturing the uterine vessels or piercing or bending the fallopian tubes.

When there is associated prolapse of the ovaries these may be suspended near the uterine cornua by pleating each ovario-uterine ligament with a stitch of catgut.

Clots are removed, the pelvis is dried with gauze mops, and the abdomen is closed in three layers.

RESECTION OF HEAD OF PANCREAS AND DUODENUM FOR CARCINOMA—PANCREATODUODENECTOMY

ALEXANDER BRUNSCHWIG, M.D., F.A.C.S., Chicago, Illinois

PARTIAL or subtotal pancreatectomy has been performed for benign and malignant neoplasms and for hyperinsulinism (2). In a recent publication, Whipple, Parsons and Mullins (4) have again shown the feasibility of removal of segments of duodenum and portions of the head of the pancreas for carcinoma of the ampulla of Vater or lower portions of the common bile duct. As far as the writer has been able to determine, wide resection of the head of the pancreas together with practically all of the duodenum for carcinoma of the head of the pancreas has not been recorded. Such an operation was recently performed by the author and appears to be a feasible procedure. The history of the patient and details of operative technique are as follows:

H. P., No. 166655, male, aged 69 years, was admitted to the medical service (Dr. George F. Dick) January 5, 1937, complaining of more or less constant pain in upper right quadrant of the abdomen radiating through to the back and to the left, of 8 weeks' duration, not aggravated by eating, increasing icterus and marked general pruritus of 7 weeks' duration, and difficulty in urination, 2 years. There had not been an appreciable weight loss. Physical examination revealed a thin white male, markedly icteric. A rounded indefinite mass was palpable in the region of the fundus of the gall bladder. Temperature was normal. The Wassermann and Kahn reactions were negative; red blood count, 4.3 million; white blood count, 5,400; hemoglobin, 90 per cent. Urinalysis revealed: albumin, negative; sugar, negative; bile, ++++; icteric index, 119; the stools were clay colored. Roentgenographic examination of the chest and fluoroscopic examination of the esophagus and stomach were negative; questionable deformity of the duodenal bulb. Cholecystograms were made but the gall bladder could not be visualized after oral administration of dye.

Clinical diagnosis: Carcinoma of the head of the pancreas, with common duct obstruction.

Operation—first stage, January 8, 1937. Spinal anesthesia was used with ethylene toward the end.

In view of the pre-operative diagnosis it was planned to do a cholecystgastrostomy as a palliative procedure. The abdomen was entered through a high midline incision. No excess free fluid was present. Palpation in the region of the head of the pancreas revealed a very firm mass about 4 centimeters in diameter adherent to the adjacent inner wall of the descending portion of the duodenum. Palpation and inspection of the liver showed no evidence of metastases. The gall bladder was markedly distended by bile, its wall was thin, and there were no stones. Palpation and inspection of the peritoneal cavity and the viscera likewise showed no evidence of metastases. A finger could be inserted into the foramen of Winslow. Because the firm head of the pancreas was movable upon the underlying tissues, it was decided to attempt resection of it by a two-stage operation based upon the principles emphasized by Whipple.

At Dr. Phemister's suggestion the following steps of the first stage were performed: (1) "short loop" posterior gastro-enterostomy with 2 rows of continuous linen sutures; (2) cholecystjejunostomy with interrupted silk sutures at a point approximately 12 inches below the above—the loop of jejunum was brought through an opening made in the right portion of the transverse mesocolon, the margins of the rent being sutured to the small bowel passing through it; (3) an entero-enterostomy below the passage of the jejunal loop through the mesocolon. The several procedures are indicated in Figure 1. It was thus possible for bile to pass into the jejunum and the entero-enterostomy permitted passage of material down the jejunum from the stomach without circulating past the gall bladder. Furthermore, the exposure for the second stage was facilitated by not having the gall bladder anastomosed to the stomach over the region of the pancreas.

Recovery from this operation was uneventful and patient was discharged January 27, 1937, for a rest period at home. On February 5, 1937, he was readmitted. The icterus had improved considerably; icteric index, 29. A glucose tolerance test performed on February 8 showed: starving blood sugar 140 milligrams per cent and 291 milligrams per cent after 3 hours, with +++ reduction of urine. A second test performed a week after the second operation showed starvation blood sugar to be 107 milligrams per cent; ½ hour, 183 milligrams per cent; 2 hours, 179 milligrams per cent and 3 hours 151 milligrams per cent. Urine was negative. There is no apparent explanation for the high values obtained in the first test.

Second stage was done February 11, 1937. Under ethylene anesthesia the abdomen was reopened through the old incision. The peritoneal surfaces appeared smooth and glistening but slightly fibrotic. There were no evidences of peritoneal metastases but the lower abdomen was not explored. The liver appeared free from metastases on both inspection and palpation. A curved incision was made through the peritoneum following the right lateral border of the descending portion of the duodenum and this loop with enclosed head of the pancreas was elevated to the left by gauze dissection. This permitted satisfactory palpation of the lesion which did not appear to have increased appreciably in size since the first operation. It was also possible to ascertain that the growth had not apparently infiltrated into the retroperitoneal tissues.

The stomach at the pyloric sphincter was divided between two clamps and the first portion of the duodenum was retracted to the right. This exposed the midportion of the common bile duct which appeared to be about the size of a lead pencil. It was divided between clamps and the upper end doubly ligated with linen.

The neck of the pancreas was palpated and beneath it a curved grooved director was carefully inserted from above downward and to the left, its tip emerging over the terminal

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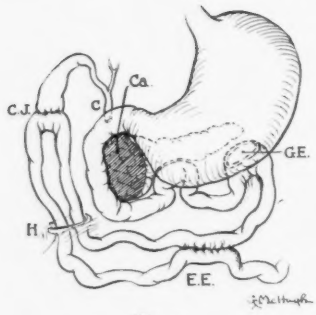

Fig. 1.

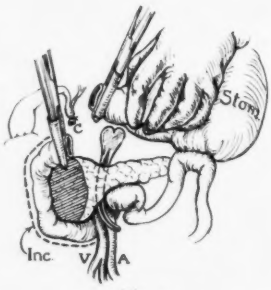

Fig. 2.

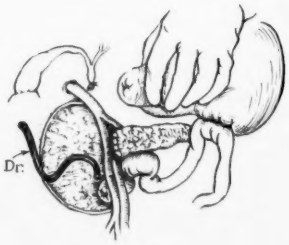

Fig. 3.

Fig. 1. First stage. *Ca*, Carcinoma in head of pancreas; *C*, common duct; *C.J.*, cholecystojejunostomy; *H.E.*, transverse mesocolon through which loop of jejunum is passed for above anastomosis; *G.E.*, short loop posterior gastro-enterostomy; *E.E.*, entero-enterostomy. The figure is diagrammatic in that the loop of jejunum employed for anastomosis with the gall bladder is not as long as shown and the entero-enterostomy was performed a short distance below the opening in the transverse mesocolon.

Fig. 2. Second stage performed a month later. *Inc.*, curved incision through posterior parietal peritoneum along convex border of duodenum to permit mobilization of head of pancreas. Division of pyloric sphincter. *C.*, Ligated common duct. Curved, grooved director is passed beneath neck of pancreas and over superior mesenteric vein, V, and *A*, artery. Neck of pancreas is transected over grooved director.

Fig. 3. Termination of operation. Excision of the head of the pancreas and duodenum for carcinoma. The practically complete removal of duodenum and head of pancreas. The stomach and duodenal stump are invaginated, the cut surface of the pancreas ligated with mattress sutures. *Dr.*, soft rubber drain to large denuded retroperitoneal space. Superior mesenteric vein is seen coursing upward to join splenic vein in formation of the portal vein.

portion of the duodenum (Fig. 2). The neck of the pancreas was then divided, the scapel coming down upon the grooved director. When the parenchyma had been partially severed, several cubic centimeters of clear, slightly viscous fluid escaped. This was pancreatic secretion dammed up in the dilated pancreatic duct. When division of the neck of the pancreas was completed, it was found that this had occurred just over the superior mesenteric vessels as they coursed downward over the terminal duodenum. The head of the pancreas and adherent duodenum were then retracted downward and to the right and removed after the latter was divided between clamps just beneath the superior mesenteric vein. The pyloric stump of the stomach was invaginated by 3 layers of interrupted linen sutures; the duodenal stump by 2 layers of similar sutures. The freshly cut surface of pancreas was ligated by 4 interrupted and interlocking linen mattress sutures, the pancreatic duct was ligated separately. A large space previously occupied by duodenum and head of pancreas remained (Fig. 3). This was drained by a small soft rubber tube and the midline incision closed.

Pathological study. The specimen consists of what appears to be practically the entire duodenum surrounding the head of the pancreas, the latter consisting for the most part of a firm mass that is inseparable from the adjacent duodenal wall. In the fixed (formalin) state the duodenum measures 18 centimeters in length and the head of the pancreas 5 by 4 centimeters. The cut surface of the neck of the pancreas does not grossly exhibit tumor tissue. The pancreatic duct is identified but a probe cannot be passed through it into the duodenum. The severed common duct is identified and a probe passes readily into the duodenum. The specimen is bisected as shown in the accompanying Figure 4. The plane of bisection does not include the plane of division of the neck of the pancreas from the body which was not removed at operation. The carcinoma, arising in the head of the pancreas, has extensively infiltrated the duodenal wall, producing at one point a small ulceration in the duodenal mucosa. The ampulla of Vater is not involved in the growth. Two small, firm, discrete lymph nodes are removed from the serosal surface of the third part of the duodenum.

Microscopic examination of a large section through the lesion and adjacent duodenal wall shows a duct cell carcinoma composed of large columnar malignant epithelial cells forming solid cords and tubules. These cell masses can be seen streaming into the duodenal wall between muscle bundles. Sections through the lymph nodes show metastatic carcinoma. Sections through a fragment of pancreas removed from the line of resection show scattered clumps of carcinoma cells. There is also marked fibrosis between clumps of alveoli, diffuse round cell infiltration, and proliferation of small pancreatic ducts.

Postoperative course. Immediate recovery from the second stage was uneventful, there being a minimal temperature reaction and no nausea or vomiting. The small drain was removed on the fifth day. A small amount of clear serous drainage persisted from the drain site in the wound and on the fourteenth day it became distinctly biliary in appearance and increased in quantity. The wound otherwise healed *per primam*. A small Pezzer catheter was inserted into the sinus and connected with a Wangensteen suction apparatus. The daily fluid loss was tabulated and reached a maximum of 560 cubic centimeters on the forty-fourth day after which it decreased rapidly in a few days to approximately 50 cubic centimeters a day and changed from a biliary character to a whitish mucoid discharge containing at intervals recognizable food particles. This fluid was not found to contain active proteolytic enzymes. It was thought at first that the ligated common duct had reopened, but the change in character of the drainage indicated it was an intestinal fistula. Repeated attempts to cause the fistula to heal were made by insertion into it of kaolin and zinc oxide pastes, but these pro-

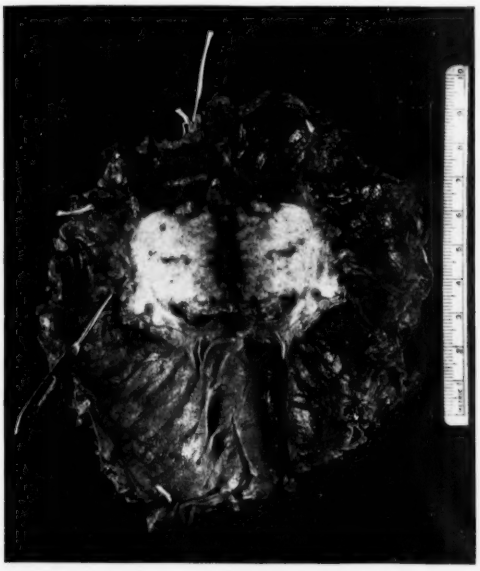

Fig. 4. Surgical specimen showing excised duodenum and enclosed head of pancreas which contained a duct cell carcinoma that had extensively infiltrated the adjacent duodenal wall. A probe has been passed through the ampulla of Vater, upward into the excised segment of common duct. These structures were not grossly involved by neoplasm. The plane of bisection of the specimen does not include the transected neck of the pancreas which did not grossly exhibit invasion by carcinoma.

Fig. 5. Photomicrograph showing growth of duct cell carcinoma of head of pancreas infiltrating duodenal wall. × 80.

cedures did not entirely succeed although the fistula was reduced to about 2 millimeters in diameter when the catheter was not in place. Because of difficulty in starting the stream, an inlying urethral catheter was inserted following the operation. On the twentieth day a transurethral prostatic resection was performed by Dr. C. B. Huggins of the Division of Urology, following which practically normal urination was possible.

In spite of the complications noted the patient's condition remained generally fair. A full diet was permitted after the twelfth day and although his lack of appetite for sufficient quantities necessitated frequent hypodermoclyses of 5 per cent glucose, adequate amounts of fluid were taken by mouth.

After the third week the patient sat up in bed or got out of bed, walked a little and sat up in a wheel chair for varying periods, almost every day. The severe pruritus subsided and the icterus had disappeared by the end of the third week when the icteric index was 13. The stools were always light in color and pasty in consistency but contained bile. This was due to absence of external pancreatic secretion. The urine, tested at intervals, showed no reduction at any time.

On April 26, 1937, the patient's condition suddenly appeared worse in that there was complete lack of any desire to eat, marked dizziness when he attempted to arise or sit up in bed, and pronounced asthenia. The blood pressure did not fall. The following day the sclera became rapidly yellow and bile appeared in the urine. There were no chills or rise in temperature. On April 30, 1937, the patient went into coma and died, this being the eighty-fifth day following the second stage of the operation. Urinalysis was negative; blood chlorides, 445 milligrams per cent and non-protein nitrogen 41, all taken a few hours before death.

Summary of principal necropsy findings: Carcinomatosis of the peritoneum with ascites (2000 cubic centimeters). Multiple large metastases throughout the liver, a small fistula leading from the inverted duodenal stump (of which section of bowel there remained about 1.5 inches) to the midportion of the healed operative wound. The closed portion of common bile duct contained yellow mucoid material. The site of the duodenum and head of the pancreas contained inspissated material undoubtedly derived from the fistula on the one hand and as a result of injections of kaolin and zinc oxide pastes through the skin opening in endeavor to close the fistula. However, this space had become much reduced in size as compared to its extent at the second stage of the operation and was well walled off from the general peritoneal cavity. Sections of surrounding granulation tissue showed numerous masses of carcinoma cells. No peritonitis and no inflammation or ulceration in the stomach and intestines were noted. The anastomoses were healed and functioning. Sections of the liver showed moderate polynuclear and round cell infiltration about the small hepatic ducts and scattered small abscesses in the

parenchyma. The liver cells exhibited no marked changes in the routine sections, nor in the sections stained by scharlach-R. No terminal pneumonia was present.

The cause of death was widespread and rapid development of secondary growths in the form of peritoneal carcinomatosis, extensive hepatic metastases, and the latter, as well as perhaps the cholecystenterostomy, contributing to a diffuse cholangitis. The survival period of almost 3 months in this case with no obvious marked metabolic disturbances due to the nature of the operation constitutes evidence for the feasibility of this type of operation in dealing with malignant neoplasms such as described above.

Total extirpation of the duodenum was for a time thought by physiologists to be incompatible with life. This impression together with the relative infrequency of operable tumors of the duodenum or head of pancreas, and the feeling that total extirpation of the head of the pancreas and duodenum was technically very difficult, no doubt contributed to the general lack of interest on the part of surgeons in these types of operations. However, as long ago as 1918 Lester R. Dragstedt and associates first demonstrated that in the dog the duodenum was not indispensable to life and that this segment of bowel did not have special internal or external secretions necessary for the function of the intestines lower down as was held at that time by some investigators.

SUMMARY

A case history is presented to show the feasibility of excision of the entire head of the pancreas and practically all of the duodenum for carcinoma of the head of the pancreas. Such an operation might also be performed for primary malignant tumors of the duodenum.

While no gross evidence of metastases was present at the time of the operations, the patient died 85 days following excision and, at necropsy, carcinomatosis of the peritoneal cavity and multiple liver metastases were found. Gross and histological examination of the liver, stomach, and small bowel revealed no evidence that the removal of practically the entire duodenum had resulted in significant metabolic disturbances during the patient's survival period.

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THE TREATMENT OF ACUTE EMPYEMA

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IN the treatment of any type of empyema the two main factors that must be considered are disinfection of the pleural cavity and re-expansion of the lung. The first of these is accomplished by properly placed drainage and irrigation; the latter, by exercises encouraging enforced expiration and measures which tend to lower the pressure within the empyema cavity. In the successfully treated patient these two factors occur simultaneously. Drainage and irrigation attenuate the infection and at the same time the lung gradually re-expands until the pleural space is finally obliterated. Not infrequently this re-expansion occurs so slowly that although the danger to life for the time may be passed, a prolonged low grade infection causes either a delayed convalescence or results in a thickened, rigid, chronic empyema cavity.

In the usual case of encapsulated empyema without bronchial fistula, open drainage following rib resection will usually suffice, provided aspiration treatment has not been prolonged beyond the point of usefulness. It is not always possible to decide at the onset which type of treatment will be the most efficacious but a sufficient number of cases of delayed healing have occurred with open drainage to stimulate many surgeons to use some form of closed drainage so that the advantages of suction can be utilized.

When drainage is carried out by means of a single tube entering the chest, one of two things may be accomplished: If fluid is allowed to run into the pleural cavity we irrigate the cavity but at the same time the intrapleural pressure is rendered positive. If we create suction in the tube and thus encourage drainage and lung re-expansion we are for the time neglecting the part played by irrigation.

With these thoughts in mind we have designed a tube which can at the outset be used for either open or closed drainage regardless of whether rib resection has been done and with which alternate open and closed drainage can be accomplished in a single case at any time if the indication appears to exist. If closed drainage is used both irrigation and suction are achieved simultaneously.

Description of tube. The tube is made entirely of rubber and may be boiled again and used several times. It consists of a double tube with an external guard which when in place is flush with the external chest wall and covers the incision. Each end of the guard is prolonged to form a strap which, when run through a button hole cut in adhesive tape or through a buckle, holds the tube firmly in place. There is a thin rubber diaphragm on the flutter valve principle which may be used with open drainage to encourage re-expansion. This latter idea is not new but the fact that the diaphragm is built into the tube has made it much more efficient than when a piece of rubber dam is used for the same purpose.

Open drainage. It is possible to carry out open drainage through an intercostal stab wound but when the pus is thick and filled with organized exudate, rib resection is usually desirable to break up pockets and remove fibrin. If a stab wound is used thorough irrigation and suction of the cavity should be done in the operating room before inserting the tube. When a rib is resected the wound is closed with silk leaving a small opening for the insertion of the tube. The rubber guard covers the incision, the under surface of which is coated with flexible collodion or some other substance that will act as a skin protection. The tube is held in place by its straps as described.

This tube appears to have certain advantages when used simply for open drainage. There is no adhesive strapping in the vicinity of the wound to become saturated with pus and the dressing itself is quickly and easily changed—the gauze is laid over the tube opening and held in place with adhesive or a binder. One of the chief advantages is that the patient can lie upon the affected side and greatly facilitate drainage, since there is no tube protruding from the chest wall. Irrigation is easily carried out without removing the tube either by inserting a bulb syringe tip into one of the openings or by using a catheter.

Closed drainage. If it is desirable to change from open to closed drainage or to institute closed drainage at the outset, two tightly fitting catheters which are first swabbed with collodion are drawn through the tube openings. The tube is then inserted into the chest and fixed in the usual manner. To insure an air tight system it is essential that the rubber guard be held firmly against the chest wall. This is accomplished by the use of sponge rubber about 1 inch in thickness and bevelled at the edges which is applied over the guard after a central opening has been cut out

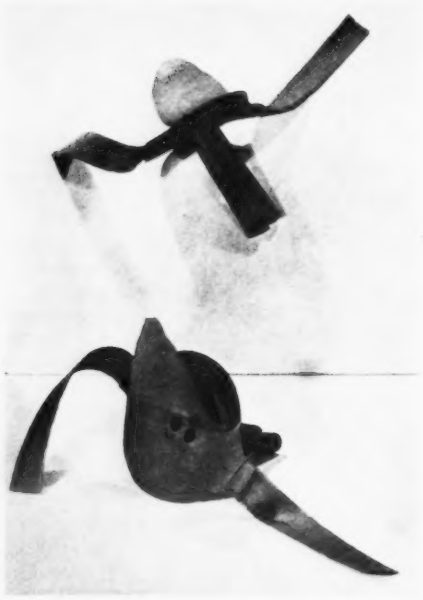

Fig. 1. Photograph of empyema tube. The mirror view shows the posterior surface which enters the chest.

to allow for the catheters. This is held in place by several 2 inch strips of adhesive tape. The periphery of the sponge should extend beyond the edge of the guard about 1 inch. One catheter is now connected with the irrigating bottle and the other to the drainage tube.

Description of suction irrigation system. The flow of solution is started from an open bottle *A*, the rate of flow being controlled by a Murphy drip, the opening in which is sealed with adhesive to exclude atmospheric pressure at this point. One catheter in the empyema tube allows for irrigation, the other for drainage. The solution flows into the chest cavity and out through the drainage tube to the collecting bottle *B*. The solution is first allowed to run rapidly in order to fill up the system and to cleanse the cavity. In the usual case the return flow becomes clear in a short time and with the filling of the system the negative pressure is established. The rate of flow is then cut down to about 60 drops per minute.

A consideration of the drainage tube will show the origin of the negative pressure. Drop *1* at the end of the tube, which should never become submerged, is acted upon by gravity and it is free to fall as soon as it has drawn drop *2* down to take its place. Drop *2* in order to move must draw

Fig. 2. Photograph of empyema tube in place. At this time the patient was being treated by the open drainage method. The flutter valve is being held up to show the tube openings.

down drop *3*. Thus, force of gravity acting on drop *1* is transmitted through the column and through the drainage tube to the chest. The theoretical value of this force is found by measuring the vertical distance from the entrance of the tube into the chest, which represents the level of fluid, and the exit end of the drainage tube. For example, a vertical distance of 15 inches represents a negative chest pressure of −15 inches of water. For all practical purposes we may assume that this is true and thus eliminate the necessity of using a manometer to check the pressure. In arranging the setup the drainage tube from the chest should drop rather sharply to the drainage bottle and not be carried along for a distance horizontally before entering the bottle, because in this case the negative pressure in the chest would be less than the vertical distance referred to, since part of the force would be exerted in overcoming the resistance to flow in the drainage line. If one feels that it is necessary to insert a manometer it should be incorporated into the system at the same vertical level as that of the fluid in the chest. It will be seen that with the pressure in the chest varying directly with the distance between the fluid level in the chest and the exit of the drainage tube change of the position of the patient would alter this pressure. We do not believe that this factor is of any great importance but have obviated it by having the drainage tube enter a larger tube so as to allow it to slide up or down with any motion on the part of the patient.

With this system of closed drainage no air-tight bottles or suction apparatus is required. The degree of negative pressure is easily controlled and changeable at any time by raising or lowering

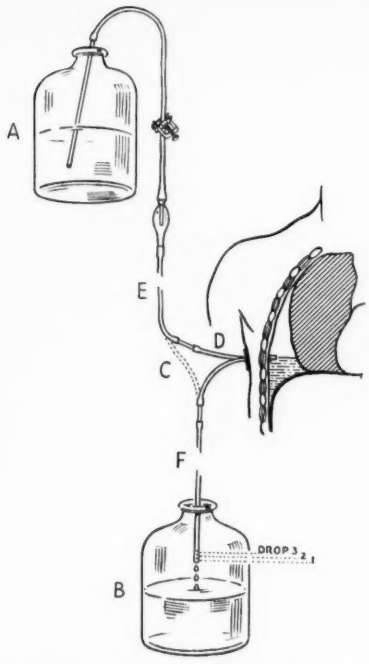

Fig. 3. Diagram illustrating the continuous suction-irrigation system of closed drainage.

the drainage tube. The required negative pressure will vary from day to day, depending upon the progress of the patient and the rate at which the lung is expanding. Likewise the rate of flow may be altered but in our experience 60 drops per minute is adequate after the drainage becomes clear. If one wishes to maintain a negative pressure and omit irrigation, a tube *C* may be incorporated into the system. Then by closing off tube *D*, the fluid runs from *E* to *F*, and the same principles of pressure apply, the only difference being that the chest is not irrigated.

For irrigation to be most effective the entire surface of the infected cavity should come in contact with the irrigating solution. We therefore cut the two limbs of the tube at varying lengths, so that the tube holding the irrigating catheter will enter the cavity an inch or more while the one for drainage is cut so that it does not extend beyond the internal surface of the chest for more than half an inch. When one wishes to flush the entire cavity, the patient is made to lie upon the sound side when the fluid level will rise to the exit of the proximal end of the drainage tube.

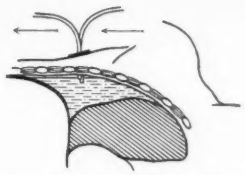

Fig. 4. Diagram illustrating the method by which the empyema cavity may be flushed.

This tube has been used in 1 case of streptococcus empyema, 1 case of severe mixed infection following the rupture of a bronchiectatic cavity, as well as in cases of pneumococcus empyema. In the first 2 patients mentioned, aspiration treatment had been carried out for a considerable period of time and when suction-irrigation was initiated there existed a complete lung collapse with mediastinal herniation to add to the problem of infection. In every case the results have been satisfactory both from a technical and clinical standpoint, and we believe that the convalescent period has been very definitely shortened.

We believe that as a rule no patient should be discharged from the hospital until the lung has completely expanded, and many patients with empyema, although progressing reasonably well, obliterate their space very slowly. Such patients should have the benefit of some form of suction-irrigation treatment, which in the past we have found difficult to do following rib resection. In our experience the situation has been considerably simplified with this ability to change from open to closed drainage and at the same time keep the empyema cavity clean with constant irrigation.

SUMMARY

1. A new empyema tube is described which may be used for either open or closed drainage.

2. A system of closed drainage is suggested which would appear to have the following advantages:

a. No closed bottles or any form of suction apparatus are required.

b. Irrigation and suction are accomplished simultaneously.

c. With the employment of this tube closed drainage may be carried out after rib resection.

The author wishes to express his appreciation to Mr. John Howe who assisted him with experimental work, and to Mr. Franklin Springer of the Davol Rubber Company who supplied, and assisted with the design of, the empyema tubes.

SIMPLIFIED PROCEDURE FOR THYROID EXPOSURE

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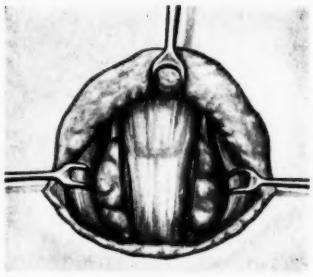
THYROID surgery is facilitated and precision of technical procedures is obtained by the utilization of three important aids: (1) the position of the patient on the operating table, (2) the control of hemorrhage, and (3) the complete exposure of the whole of the operative area.

The technical procedures for subtotal resection of the thyroid have become standardized and most surgeons divide the ribbon muscles on each side of the median line to obtain adequate exposure of the thyroid gland. The space between the hyoid bone and the sternum is occupied by the so called ribbon muscles—the superficial group consisting of the sternohyoid and omohyoid and beneath these a broader and shorter muscle—the sternothyroid. The usual procedure is to incise the cervical fascia in the median line and then to divide the ribbon muscles on each side between the upper and middle third. When this procedure is completed, by retraction upward and downward of the divided muscle groups and lateral traction on the sternomastoid on either side, full and ample exposure is obtained. In the course of our thyroid experience this bilateral procedure has been simplified by dividing both lateral groups of the ribbon muscles between two clamps, thus giving an even larger and more ample exposure and making the operative field less encumbered by two clamps rather than by four. A superficial search through standard textbooks on surgery and a cursory review of recent technical literature does not depict this procedure but its simplicity must have suggested itself to other surgeons. Its application in thyroid surgery may be described as follows: With the patient in a semi-sitting position the shoulders resting on a sand bag, the head extended, the entire field of the neck is draped and the usual partially curved thyroid incision is made, with a slight concavity upward. The skin and subcutaneous fat are dissected upward on the upper flap and to a less extent downward on the lower flap, until the platysma and subjacent muscles of the neck are brought fully into view. No attempt is made to divide the platysma myoides as such, nor to leave it attached to the upper or lower skin flaps. With the surgeon standing on the right side of the patient, the superficial cervical fascia is divided for approximately 7 centimeters along the anterior border of the right sternomastoid muscle. A Parker retractor with lateral traction pulls the fleshy body of the sternomastoid muscle outward exposing the pretracheal fascia as it moves forward from the parotid sheath. The upper belly of the omohyoid muscles will be plainly visible, transversing this space from the hyoid bone downward and outward toward the scapula. The omohyoid is usually retracted upward and the pretracheal fascia incised more or less paralleling the incision along the anterior border of the right sternomastoid. The sternothyroid muscle is readily identified and its lateral edge picked up with thumb forceps. The index finger of the left hand can then be insinuated beneath the three ribbon muscles on the right side with the palmar surface of the finger passing anteriorly over the thyroid gland. The finger passes readily beyond to the median line under the left group of ribbon muscles. The index finger is then turned so that the palmar surface is turned upward and the same incisions are made on the left side at the anterior border of the sternomastoid muscle (Fig. 1). The index finger of the right hand is inserted into the cleft thus made so that there is underneath both groups of ribbon muscles—the left and right—the index finger of the left hand and the index finger of the right hand. The muscles are raised off the isthmus of the thyroid and two Kocher clamps are inserted by the first assistant, one paralleling the left index finger, with the handle of the clamp on the right side of the patient, and the second clamp paralleling the index finger of the right hand and the handle of the clamp on the left side of the patient. These two clamps are applied at approximately the junction of the upper and middle third of the muscle group (Fig. 2). The muscles are then divided and, with a hook retractor placed under each clamp, traction is made upward and downward, and the entire thyroid area is fully exposed (Fig. 3). At the termination of the resection of the thyroid, the retractors are removed and the muscle groups approximated and united by three interrupted sutures of No. 1 chromic catgut (Fig. 4). A latex drain is placed in each thyroid fossa and brought out at approximately the midpoint of the sternomastoid muscles. The lateral incisions on each side are approxi-

From the Department of Surgery, New York Post-Graduate Medical School and Hospital, Columbia University.



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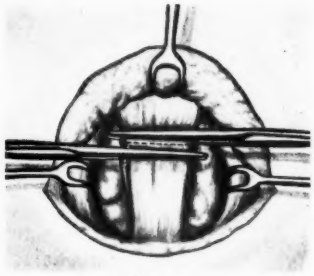

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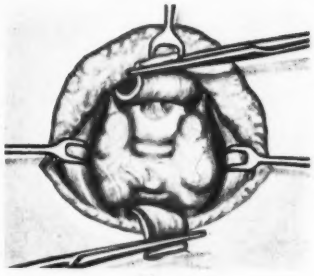

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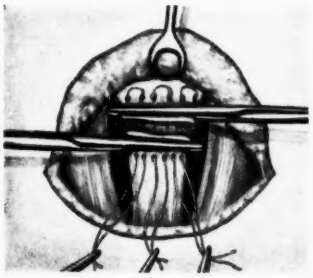

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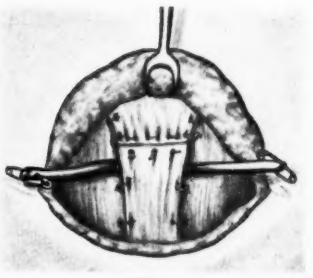

Fig. 5.

Fig. 6.

Fig. 1. The skin flaps have been retracted and the ribbon muscles divided on each side to their attachment to the sternocleido muscle.

Fig. 2. The ribbon muscles on both sides are divided transversely at junction of upper and middle third.

Fig. 3. The ribbon muscles as a single musculofascial sheet are retracted upward and downward thus exposing the entire thyroid gland.

Fig. 4. The ribbon muscles are united by means of three interrupted mattress sutures of No. 1 chromic catgut.

Fig. 5. The musculofascial group of ribbon muscles are united on each side to the sternocleido muscles, after the insertion of a drain on each side.

Fig. 6. The drains emerge laterally and the skin is united with Michel clips.

mated with interrupted sutures of No. 1 chromic catgut (Fig. 5).

The remainder of the operation consists only of the skin closure with Michel clips and the emergence of a drain on each side near the outer extremity of the skin incision (Fig. 6). The procedure outlined (1) has provided a more ample exposure than heretofore; (2) has lessened the number of clamps in the operative area; (3) has lessened the actual technical time of the operation; and (4) healing and subsequent course of the thyroid wound has been expedited. Serum collection beneath the skin has been less frequent and the return of the normal contour of the neck has, in our opinion, been hastened.

No claim of originality is made for this procedure and our only purpose is to give emphasis to an operative procedure that facilitates exposure and as well lessens technical difficulties in thyroid surgery.

BUMPER AND FENDER FRACTURES

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FRACTURES about the knee joint are not rare. Within recent years, however, they have been brought into prominence largely through the increased use of the automobile as a mode of transportation and the application of the roentgenogram in making a diagnosis.

Only 7 years ago F. J. Cotton and Richard Berg gave this type of fracture its name "bumper fracture." They define a bumper fracture as a crushing injury produced by abduction of the leg forcibly enough to smash the external tuberosity of the tibia against the fulcrum of the lateral condyle of the femur. This is the classical type of bumper fracture. Due to the increased speed of the automobile and the attempt to increase the riding comfort, the height of the automobile chassis from the ground has been lowered. The bumpers and fenders have also descended to a lower level. The fact explains the recent types of bumper fractures, not at the level of the knee joint but 1½ to 2 inches below, or even lower.

From the female fracture ward of Cook County Hospital. Dr. Goren, fracture resident, Cook County Hospital.

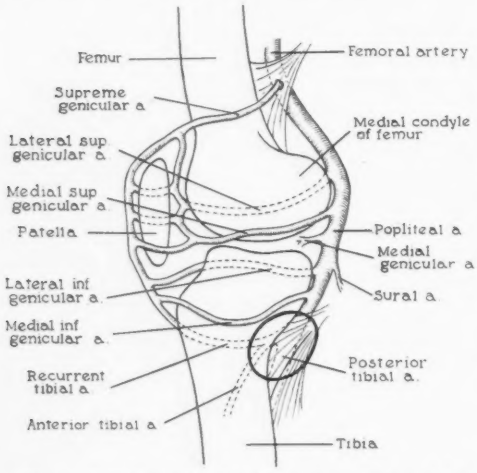

Fig. 1. Drawing of the circulation about the knee joint. The heavy oval shows the most dangerous area for involvement of the circulation of the leg. Injury of the vessels in this area leaves no channel for collateral anastomoses and gangrene may frequently result. (Modified from Callender).

The newer type of bumper fracture has added the hazard of nerve and blood vessel involvement, which is more frequent than formerly.

Within the past 6 months 4 cases of gangrene of the lower extremity were observed in the fracture wards of the Cook County Hospital—1 case in a child with a fracture of the middle third of the femur, another in an adult male of 47, and 2 in adult females. Three of these 4 cases developed cyanosis, coldness, and blebs characteristic of moist gangrene of the foot. These blebs became infected and required amputation of the leg. The other patient developed a dry gangrene of the distal end of the foot, requiring amputation of the toes.

PATHOLOGICAL ANATOMY

Harold G. Lee in his article on fractures of the tuberosities of the tibia, cites the studies of the architectural structure of the upper end of the tibia made by Barbilian, who has shown that the direction of the fracture line is determined in general by the disposition of the trabeculæ making up the bony tissue. In a sagittal section these trabeculæ are separated into two systems, an anterior and a posterior, which cross each other in arch formation. The anterior and posterior trabeculæ located lower down, finish on the opposite faces of the bone, while the higher ones terminate on the articular surface itself. Barbilian has shown (1) that the trabeculæ always cross each other perpendicularly and (2) that they fall perpendicularly on the articular surface. This allows the bone to withstand great pressure. In a frontal section, 2 groups of trabeculæ are seen, 1 for each tuberosity, which start from the lateral faces of the bone and run perpendicular to the corresponding articular surface. The space between the 2 groups appears to be occupied by the section of the trabeculæ seen in the sagittal view. These trabeculæ are bound by other trabeculæ that run in a horizontal direction. In a transverse section, the trabeculæ show between them little canals, the dimension of which varies according as they are located in front, back, or on the sides.

This explains the line of fracture, which is usually vertical in the direction of the trabeculæ; exceptionally it may be oblique and rarely transverse. The direction of the fracture line varies, of course, with the point of termination of the tra-

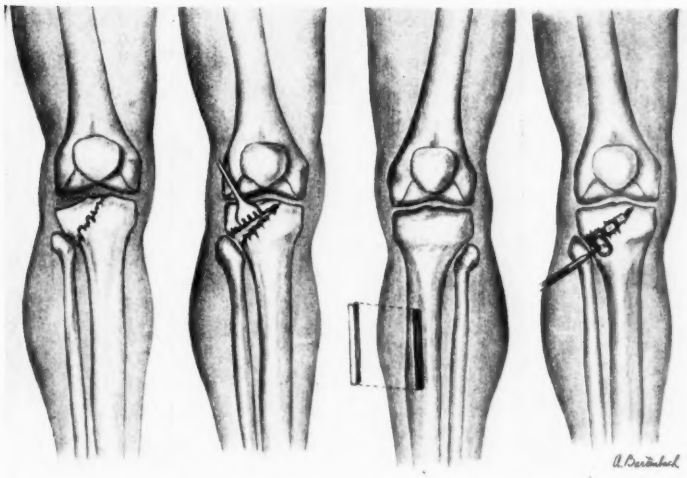

Fig. 2. Schematic drawings showing the major steps in the procedure for elevating the depressed condyle of the tibia. Reading from left to right: 1, A typical depressed tuberosity of the tibia. 2, The depressed condyle elevated into position by means of an osteotome and held there by a retractor. 3, The bone graft removed from the flat surface of the opposite tibia by means of an electric saw. 4, The bone wedges being driven in to maintain the depressed condyle in position.

beculæ. The farther down the fracture line is from the articular surface, the more nearly vertical it is, with a tendency to become horizontal as it approaches the articular surface. In cases of direct fracture the lines follow no particular course. In these cases the line of fracture follows the line of force applied, and this would appear to vary with the degree and duration of the force.

In the *newer* types of bumper fractures, vascular involvement with gangrene may result if the injury to the vessels occurs below the openings of the inferior genicular arteries, or veins, because no collateral circulation is possible (Fig. 1).

Cubbins and associates have classified fractures of the lateral condyle of the tibia into 5 types and have suggested treatment of each type.

Type 1. Fracture of the lateral condyle. The fragment is displaced outward with little if any of the bearing surface depressed.

Type 2. Depressed fracture of the lateral condyle. A large fragment is displaced outward and the medial portion of the bearing surface is depressed obliquely downward and inward.

Type 3. Oblique depression fracture of the bearing surface with only a small portion of the lateral fragment retaining normal level.

Type 4. Depression fracture of the posterior portion of the lateral condyle, with the forward portion intact.

Type 5. Depressed fracture of the anterior portion of the lateral condyle, with the posterior portion intact.

ETIOLOGY AND MECHANISM

One may produce a fracture of the lateral tuberosity of the tibia by falling from a height with the leg extended and an abduction force directed at the leg; or by an automobile fender or bumper striking the extended and locked knee. Something must give way. In unusual cases there may result a tear in the lateral collateral ligaments of the knee or of the lateral condyle of the femur. The internal collateral ligament or the medial tuberosity of the tibia may be avulsed, but most often the lateral articulating surface of the tibia gives way and a knock knee deformity results.

N. Barbilian, quoted by Arthur N. Collins, was unable to produce fractures of the tibial head by mere internal or external rotation. When to torsion was added a direct blow, the fracture resulted.

Eliason is of the opinion that the point of contact of the femoral condyle with the tibial plateau will depend on the degree of flexion of the knee at the time of direct trauma. In flexion the posterior portion of the tibial plateau, or shelf, would tend to be crushed, while in extension, the crush would be more anterior, with a resultant "back-knee."

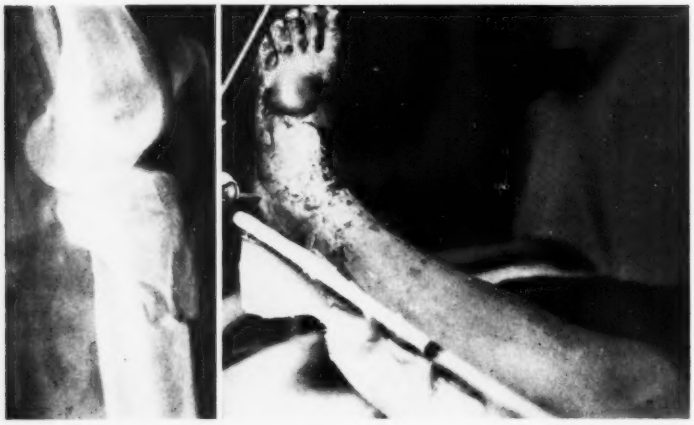

Fig. 3. Case 1. M. G., aged 26 years. Admission No. 1625867. Patient was struck by an automobile while crossing the street and was admitted to Cook County Hospital January 17, 1937. A fracture of the left tibia and fibula at its upper third was sustained. There was a posterior displacement of the lower fragments. The roentgenogram was taken the next day and shows good alinement of the fragments after manipulation and closed reduction under ether anesthesia.

Fig. 4. Case 1. M. G. Picture showing the presence of marked cyanosis of distal end of foot with a large bleb formation which became infected. Two days after entrance the patient began a septic course. Skeletal traction was applied through a Steinmann nail in the os calcis. Amputation below the knee was done on February 12, 1937. The wound healed cleanly. Union present in fracture. Note line of demarcation below upper third of leg.

SYMPTOMS

Pain over the site of the injury is a constant finding. The knee joint is swollen and the patella may be floating because of the intra-articular hemorrhage. There is limitation of flexion or extension depending on the type of injury, and there may or may not be a genu valgum, depending on the position of the fragments. The history, symptoms, and clinical signs are inconclusive. The roentgenogram establishes the diagnosis.

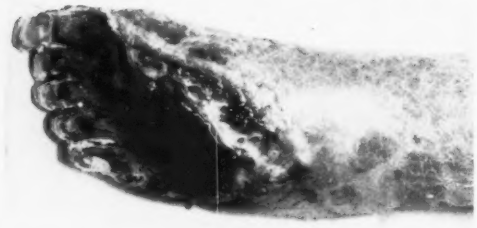

Fig. 5. Case 2. H. S., aged 9 years. Patient was struck by automobile and entered Cook County Hospital October 8, 1936, with a fracture of the lower third of the femur. Gangrene of distal end of foot due to injury to blood vessels.

TREATMENT

At present, bone surgeons are divided into two camps when the question of treatment comes up for discussion. Cotton (3), Eliason (quoted previously), and Sever, to mention a few, would prefer not to operate on any type of fracture of the lateral tuberosity of the tibia.

The non-operative methods consist of manipulating the fractured fragments into position and impaction by the Cotton method, such as striking a sharp blow with a mallet to bring the fragment upward into position; or using a *redresseur* after the method of Forrester; or applying strong finger pressure to the fractured fragments, pushing them into place. The knee is kept in an overcorrected position during the manipulation and is fixed in a plaster cast, extending from the toes to the groin. The cast is usually kept on for 6 to 8 weeks. After that, passive and active motion is begun. The patient is fitted with a walking caliper and no weight bearing is allowed for at least 3 more months.

To operate in an area of crumbled and crushed cancellous bone would add insult to injury. In case of wide separation of a good sized fragment of the tibial tuberosity without much comminu-

Fig. 6. Fig. 7.

Fig. 6. Case 3. L. C., aged 17 years, admission No. 1621656, was struck by an automobile and admitted to Cook County Hospital in marked shock on December 26, 1936. Roentgenogram taken 8 days later showed marked swelling of the soft tissues and overriding of the bone fragments. The patient began a septic course 3 days after admission. The foot was cold and cyanotic. There was absence of the dorsalis pedis pulse. Bleb formation and moist gangrene developed. Amputation 2 weeks later did not relieve sepsis. Osteomyelitis of the other leg developed.

Fig. 7. Case 4. C. W., aged 68 years, admission No. 1599674, was struck by an automobile and admitted to Cook County Hospital on September 6, 1936. The patient was in marked shock. There were fractures of both bones of both legs in the upper third. No cyanosis or gangrene developed. The patient never came out of shock and died September 15, 1936.

Fig. 8. Case 5. A. W., aged 65 years, admission No. 1575614, was admitted to Cook County Hospital May 8, 1936, with a history of having injured her right knee when her heel caught in a knot-hole, while going down a wooden staircase. The right knee was swollen and painful. There was excess lateral mobility of the knee joint and the weight bearing line was disturbed. Manual manipulation and immobilization in a plaster case for 8 weeks. Note the amount of bone destroyed due to compression.

Fig. 9. Case 5. Roentgenogram taken 4 months after the injury showing regeneration of the depressed lateral tuberosity of the tibia but there is present a "knock knee" deformity. The patient is shown wearing a walking caliper. A wedge operation to raise the depressed condyle is indicated.

Fig. 8. Fig. 9.

Fig. 10. Fig. 11.

Fig. 10. Case 6. Patient aged 40 years, admission No. 1598512, was admitted to Cook County Hospital September 1, 1936, with a history of being struck by an automobile while standing on the street. Note the large bone fragment of the lateral tuberosity of the left tibia with practically no depression. Attempt at manipulation failed to force the loose fragment in place.

Fig. 11. Case 6. Open reduction showed that the lateral meniscus was interposed between the fragments. The torn semilunar cartilage was removed and the fragment fixed in place with a long screw. Roentgenogram taken 10 weeks postoperatively shows complete union. Note perfect weight bearing line.

tion, crushing, or impaction, and manual or closed reduction failing, due perhaps to interposition of soft tissues such as fragments of semilunar cartilage, open reduction and fixation is indicated.

When there is marked valgoid deformity due to loss of bearing surface from impaction, Cotton's suggestion to do "Macewen's" supracondylar osteotomy should be considered.

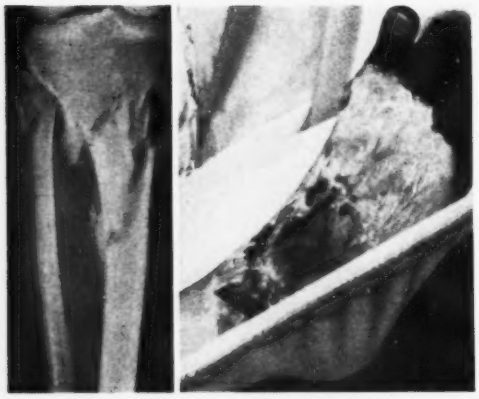

Fig. 12, left. Case 7. J. L., aged 48 years, admission No. 1627031, was struck by an automobile and admitted to Cook County Hospital, January 23, 1937, with a comminuted fracture of the upper third of the tibia and fibula. Roentgenogram taken 6 weeks after the injury shows very little callus formation. No union was present 10 weeks after the original injury.

Fig. 13. Case 7. Photograph of leg, showing dry gangrene of toes and slough on dorsum of foot.

We wish to make a preliminary report of a special technique devised by the senior author, F. G. Dyas, for elevating depressed tuberosities of the tibia. The procedure is essentially as follows:

A longitudinal incision over the affected condyle is made. The condyle is elevated to the level of the tibial articular plateau by an osteotome. By means of a motor driven saw, a graft 8 to 10 centimeters long and about 1½ centimeters wide is cut from the flat surface of the opposite tibia. The graft is then driven between the elevated condyle and the shaft of bone for about 2 centimeters and then cut off. The same procedure is repeated until a row of wedge-shaped portions of the graft, completely fill in the hiatus between the small upper fragment and the shaft of the bone. These small grafts exercise a continuous pressure upward upon the small articular fragment, forcing it against the articular surface of the femur. The wedge grafts are introduced in such a manner that the cut surface of the graft will come in contact with the freshened surface of the fragments to favor osteogenesis. We have not followed our cases for a sufficient length of time to present data of comparative results, but wish to report this procedure with the hope that, perhaps, some other surgeons may attempt the same procedure and thus increase the number of cases in order that the merits of this operation may be evaluated.

SUMMARY AND CONCLUSIONS

1. The recent types of bumper fractures occur below the knee joint and therefore the frequency of indirect traumatic gangrene is increasing.

2. To operate in an area of crushed and crumbled cancellous bone would add insult to injury.

3. A new technique is described for elevating depressed condyles of the tibia.

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FRAGMENTATION AND EXPULSION OF A COMMON DUCT STONE INTO THE DUODENUM BY USING ETHER AND AMYL NITRITE

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THE more general use of roentgenologic visualization of the common bile duct and hepatic duct by the injection of opaque substances into them both at the time of, and subsequent to, operation has assisted in determining the restoration of function of the extrahepatic biliary tract following surgical procedures (6). In this respect evidence of persisting pancreatitis is noted by persisting narrowing of the pancreatic portion of the common bile duct and dilatation of the duct above the enlarged pancreas. Occasionally, reflux of the opaque substance into the duct of Wirsung is present. On a few occasions in our experience, subsequent studies of the common bile duct by this method have proved that a lesion which appeared to be a pancreatitis disclosed evidence of an intermittent spasm of the sphincter of Oddi, and in an occasional rare case a small carcinoma of the papilla of Vater was found (5). Following difficult operations on the gall bladder and common bile duct in cases in which patients were seriously ill, we have, on two occasions, demonstrated the presence of stones in the ampulla of Vater, which produced clinical symptoms of intermittent obstruction. In one of these cases the stone was removed surgically while in the other case fragmentation of the stone was produced by instillation of ether into the common bile duct, as recommended by Pribram. The ether, in addition to causing fragmentation of the stone, increased the intraductal pressure. By dilating the sphincter of Oddi by inhalations of amyl nitrite, as recommended by McGowan, Butsch and Walters, fragments of stone were forced from the common bile duct into the duodenum. Roentgenographic evidence confirmed the clinical diagnosis of stone in the ampulla of Vater (Fig. 1) and showed the fragmentation of the stone after several instillations of ether into the duct (Fig. 2) and the expulsion of the fragments into the duodenum. Following this expulsion of the stone, roentgenographic examination which was made after the injection of brominol revealed that the outline of the common bile duct was normal and that the brominol passed freely into the duodenum (Fig. 3). Closure of the T-tube prior to these procedures was followed by attacks of pain and pylorospasm; closure of the T-tube subsequent to fragmentation and passage of the fragments of the stone into the duodenum produced no symptoms of biliary obstruction. The T-tube was removed, the sinus healed promptly, and the patient has been free of any evidence of disease of the biliary tract. He has been in excellent condition since the middle of February, when the T-tube was removed.

From the Section on Surgery, The Mayo Clinic, and the Division of Surgery, The Mayo Foundation.

REPORT OF CASE

A priest, 50 years of age, was first seen at the clinic November 9, 1936. A cholecystectomy had been performed in 1928. In the year before he came to the clinic he had suffered on 2 occasions from symptoms of obstruction of the common bile duct, that is, pain in the right upper quadrant of the abdomen, nausea and vomiting. During the last attack, which had occurred only 2 weeks before we first saw him, there had been associated chills, fever, and a mild degree of jaundice. Examination revealed that the jaundice had subsided and the patient was in good physical condition. Because of the history of the 2 attacks which were characteristic of obstruction of the common bile duct, a diagnosis of a stone in the common bile duct was made.

Exploratory laparotomy was performed on November 13, 1936. The stump of the gall bladder containing a stone was removed. The hepatic artery was in an anomalous position; it crossed the common bile duct from left to right so that, although the common bile duct was enlarged to about 2 centimeters in diameter, only a portion 1 centimeter in length was not covered by the artery. In this exposed portion of the common bile duct a small incision was made, a scoop was introduced into the ampulla, and a dark, irregular stone, which measured about 1.5 centimeters in diameter, was removed. Because of the position of the anomalous hepatic artery and the patient's obesity, it was impossible to explore the intrahepatic ducts, as an exploring scoop or forceps could not be inserted upward around the curve of the artery. It was necessary, therefore, to be content with dilatation of the sphincter of Oddi with a large sized scoop, which measured approximately 1.2 centimeters in diameter, hoping that if stones were present in the hepatic duct they would pass through this dilated sphincter.

Postoperative convalescence was uneventful and the patient was dismissed from the hospital 18 days after the operation. In all cases in which a T-tube has been inserted

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Choledochogram showing filling defect in the distal end of the common bile duct and a small amount of the medium in the duodenum.

Fig. 2. Choledochogram made after the injection of ether and showing a fragmentation of the stone which was causing the filling defect.

Fig. 3. Choledochogram showing that the common bile duct has emptied without obstruction to the medium and that the stone which was causing the filling defect in the other figures has been expelled into the duodenum.

to drain the common bile duct, it is our custom to make a choledochogram (4, 6) before removal of the tube. This is done to insure complete emptying of the common bile duct and hepatic duct in a 10 minute period and also to exclude persisting obstruction as a result of pancreatitis, stones, carcinoma or spasm of the sphincter of Oddi. A choledochogram which was made December 1, 1936, 18 days after the operation, showed a dumb-bell shaped filling defect in the distal end of the common bile duct (Fig. 1). The patient was sent home for 4 weeks and instructed to clamp his T-tube continuously during the last week before he returned to the clinic. During this week, while the T-tube was clamped continuously, the patient experienced an attack of pain in the right upper quadrant of the abdomen with accompanying nausea and vomiting. Jaundice was not present. A second choledochogram which was made on December 28, 1936, revealed that the filling defect was still present in the distal end of the common bile duct.

Our exploration of the common duct had been thorough at the time of the operation so we felt justified in assuming that the stone which we could now demonstrate in the common duct had been washed down by the flow of bile from the hepatic ducts.

In 1935, Pribram described a method whereby he had been able to dissolve certain types of stones in the common bile duct by the injection of ethyl ether through a T-tube leading into the common bile duct. Accordingly, about 5 cubic centimeters of ethyl ether was injected very slowly into the T-tube daily on January 3, 4, and 5, 1937. There was some pain associated with the procedure but this could readily be relieved by opening the T-tube, thereby releasing the increased intraductal pressure which had been caused by the rapid vaporization of the ether when brought to body temperature. Care was exercised to leave the T-tube open for at least 3 hours following each injection. A choledochogram which was made on January 6, 1937, revealed a picture which we interpreted to mean that there had been a fragmentation of the stone in the distal end of the common bile duct (Fig. 2). The picture, we thought, demonstrated very clearly that small amounts of the radiopaque medium had infiltrated through fragments of the stone. We felt that we had been unable to introduce enough ether into the T-tube at one time to insure that a proper amount of the solvent reached the stone. The rapid vaporization of the ether caused a rapid increase in the intraductal pressure which made it necessary to open the T-tube. This was followed by a prompt expulsion of gas and liquid. Therefore, on Dr. Osterberg's suggestion, we used for our subsequent injections a mixture of 1 part ethyl alcohol and 2 parts ethyl ether. Injections into the T-tube were made again on January 9, 1937, and January 11, 1937. By using this mixture of ether and alcohol, we were able to inject about 5 cubic centimeters at a time before releasing the T-tube and were able to use at least 10 cubic centimeters of the mixture each day. On January 11, 1937, about 3 hours after the injection had been made, the T-tube was clamped. About 2 hours later the patient began to experience rather severe pain in the right upper quadrant of the abdomen, with associated nausea. He was given the contents of a pearl of amyl nitrite by inhalation and the prompt relief of the pain was dramatic. A choledochogram, which was made on January 15, 1937, showed that there was no filling defect in the outline of the common bile duct and that the duct emptied its contents readily into the duodenum (Fig. 3). The T-tube was kept in place for another 3 weeks, during which time it was kept closed continuously. The patient

experienced no discomfort or nausea during this time. Consequently, the T-tube was removed January 30, 1937, and the sinus tract closed promptly. The patient said, during a recent examination (April 7, and August 7, 1937), that he was in excellent health and had had no recurrence of his biliary symptoms.

SUMMARY

A case is reported in which the presence of a persisting stone in the ampulla of Vater was demonstrable by choledochography. Fragmentation of the stone with ether and expulsion of the fragments into the duodenum were accomplished by increasing the intraductal pressure by means of ether vapor and dilatation of the sphincter of Oddi by inhalation of amyl nitrite. The value of postoperative studies of the conformation and the emptying time of the common bile duct, by roentgenographic means after the injection of opaque substance into the common bile duct, is emphasized.

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LOCALIZATION AND REMOVAL OF FOREIGN (METALLIC) BODIES

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THOUGH the removal of foreign bodies from the tissues, particularly needles imbedded in the hands and feet, is considered to be a difficult procedure, it is the opinion and experience of the author that if properly performed, the operation should require little time and cause little difficulty.

Several rules concerning the subject may be stated.

1. The time required for, and the ease with which, removal of the foreign body can be accomplished, is proportional to the accuracy with which the object is localized (which includes accurate skin markings) and the care with which the operation is planned.

2. No massive dissections should be necessary, the removal of the foreign body (needle) seldom requiring an incision longer than $\frac{3}{8}$ of an inch.

3. The anatomical part containing the foreign body should be fixed and held in an optimum operating position from the time the localization and skin markings are made until the foreign body has been removed.

4. Removal of a foreign body should never be attempted without the aid of a fluoroscope.

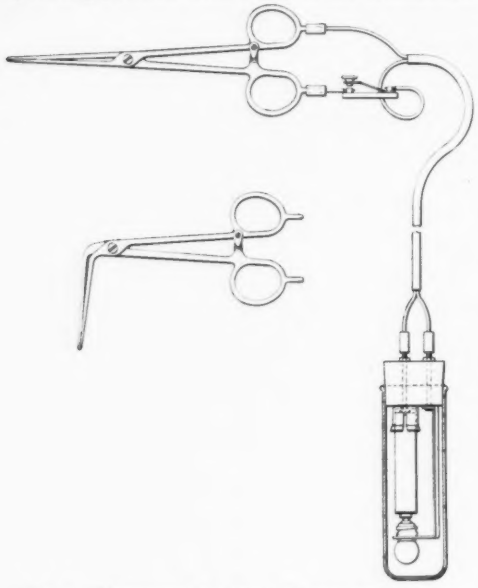

Fig. 1. Diagrammatic sketch of apparatus, showing forceps, lighting device, and contact button.

Since the same principles and method may be applied to other parts of the body, the removal of needles from the hand only will be described here.

Localization. The hand is thoroughly scrubbed with soap suds, dried, and fixed with tape ties to a perforated board as shown in Figure 2. Under the fluoroscope, the position of the needle is now marked on the skin in the following manner. An ordinary paper clip is straightened out leaving one loop as a handle, and the clip is placed on the skin and superimposed over the image of the needle as seen on the screen. The clip held in this position on the skin is used as a ruler, and a line is drawn on the skin with gentian violet. The line *A B* in Figure 2 is thus obtained. Under the fluoroscope again the ends of the needle are marked, resulting in lines *C D* and *E F*, Figure 2. Now either the hand or the fluoroscope (if a portable machine is being used) is rotated until a lateral view is obtained and the marking *G H* in Figure 2 is made and indicates the depth as well as the direction of the needle, for it is essential to determine which end of the needle is nearer the skin.

Removal. The apparatus which has been devised and is illustrated in Figure 1 consists of a forceps of desired shape and size, which has been so insulated and so constructed that its contact with a metallic object closes an electrical circuit and lights a battery controlled lamp. The lighting device may be plugged onto the forceps desired. A contact button is incorporated for making and breaking the circuit since constant electrical current produces a slight but harmless bubbling in the tissues. The apparatus is a single unit, and therefore serves both to indicate when the metallic object has been reached and to grasp the object. Contact with a nerve will produce a reaction and indicate that an important structure lies in the operative field. Only full contact with the metallic object will complete the circuit, so that the interposition of any tissue grasped between forceps and needle will prevent the lamp from lighting.

Fig. 2. Shows hand and arm fixed to board, and position of needle marked on skin.

Fig. 3. In this photograph the long scar represents an incision made several years ago for removal of a needle; the short one represents incision made recently for removal of needle by forceps method. (The scars have been inked for better visualization.)

Extraction of foreign body. The hand, fixed to the board, is prepared surgically as the operator desires. Under local anesthesia an incision ¼ to ⅜ of an inch long is made through the skin over the most superficial end of the needle. For a needle in the position as shown in Figure 2, the incision would be made at point *B*. Under certain circumstances, however, it may be advisable that the incision for approach be made over the middle of the needle. This, however, the operator must plan carefully and accurately. A pressure bandage applied over the incision for a few minutes will generally control the skin bleeding. With the hand again under the fluoroscope, the selected forceps is inserted into the wound and gently directed toward the needle. Contact of forceps tip and needle will be indicated by illumination of the lighting device. The forceps is now opened and with it the needle is gently grasped. A steady illumination indicates that the needle is in the jaws of the forceps, and that no tissue is interposed. The forceps is closed, the hand is removed from the fluoroscope, and the needle is easily extracted. If the needle has been grasped too far from its end for easy extraction through the incision, it may be pushed up against the skin a short distance from the incision and through a minute incision over its palpable end can easily be extruded and extracted. No suturing is necessary. A simple, firm dressing and bandage are applied. The removal of the needle seldom requires more than a few minutes.

In parts of the body where anteroposterior and lateral views may easily be obtained under the fluoroscope, it is well to approach the foreign body as has been described, then to rotate either the fluoroscope or the anatomical part at an angle of 90 degrees and to continue the approach. This procedure enables the operator to observe the distance between the forceps and the object. The foreign body lying in a muscle belly may be seen to move as the forceps lying close to the foreign body is moved. One should not be misled by this fact in believing that contact has been made with the foreign body. Only when the lighting device indicates that contact has been made with the metallic object should the extraction be attempted.

SUMMARY

A simplified method for extracting metallic foreign bodies is described emphasizing a new instrument.

With the aid of this instrument and the method of localization described, extensive and tedious dissections should be infrequent.

A NEW SUTURE FOR TENDON AND FASCIA REPAIR

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IN REPAIRING defects of tendons and fasciæ the tension of the retaining suture tends to cause separation between the fibers and may result in inaccuracy and weakness of the suture line. Research work previously reported[1] has shown that the fibers themselves have relatively high tensile strength, and histological studies have shown that these fibers are covered with a delicate layer of mesothelial cells. Photomicrographs of the Achilles tendon (Fig. 1) show that between the individual fibers are spaces which permit synchronization of movements of this tendon.

The method of repairing defects in tendons and fasciæ should be so designed that the strength of the fibers themselves be fully utilized and any slippage should be avoided. The end of the tendon or fascia is re-enforced by using a suture which forms an everted V, the apex of the V pointing toward the defect. The details of placing this re-enforcing suture are shown in Figure 2, A and B. This is obtained by using a figure-of-eight suture, the portion forming the V being illustrated by heavy lines. After the re-enforcing suture has been placed in position the repair is accomplished by placing the retaining suture through the V of the re-enforcing suture (Fig. 2, C). When tension is applied to the re-enforced end of tendon or fascia, it is immediately transferred through the re-enforcing suture to the fibers themselves. The same engineering principle is used in handling a cable composed of individual strands of wire. A similar technique has been successfully used by the author in designing instruments for living suture repair.[2] Figures 3 and 4 show the re-enforcing and retaining sutures in place demonstrated on a human tendon. Silk has been found satisfactory for the re-enforcing sutures, while either foreign material or living sutures may be used for the retaining suture depending on the surgical judg-

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Fig. 1. Photomicrograph of the Achilles tendon. The fibers are approximately parallel and spaces will be noted between the groups of fibers as well as the fibers themselves.

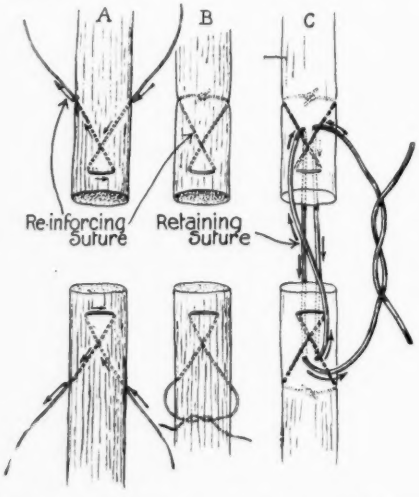

Fig. 2. The method of placing the re-enforcing suture is shown in A, the method of tying in B. The heavy dotted lines in B represent the finished V. The method of placing the retaining suture through the V's is shown in C. Whether a single or a double suture is used depends on the individual case.

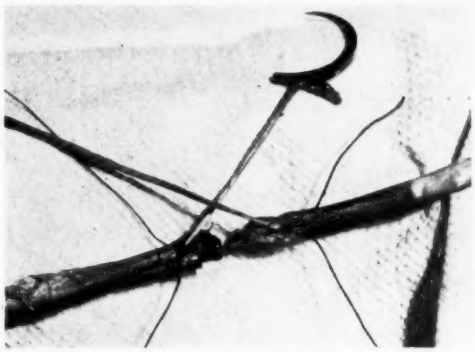

Fig. 3. The re-enforcing sutures are shown in place before they are tied. In this case a living retaining suture is being used.

ment of the operator. If a tendon or fascia is being sutured to bone only one re-enforcing suture is necessary. In the case of repairing

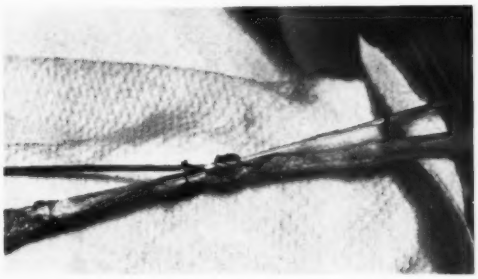

Fig. 4. The three sutures finally in place.

defects in individual tendons or in fasciæ two re-enforcing sutures, as illustrated, are necessary. The strength of internal fixation by this method has been found to be adequate, and the method has been used clinically for several years with satisfactory results. Increased suture strength and accuracy of internal fixation allows much earlier motion.

OPERATIVE CHOLANGIOGRAPHY

P. L. MIRIZZI, M.D., F.A.C.S., Córdoba, Argentina

AT THE third Argentine congress of surgery in Buenos Aires, in 1931, I called attention to the advantages of cholangiography, during operation, in revealing the nature of the obstruction present and the functional capacity of the bile passages. More recently, in a series of articles, I have reported the results of my study of the physiopathology of the hepatic and common ducts, of the diagnosis of their pathological states (4–10), and of the surgical procedures indicated in disease of the principal excretory duct (11–13).

Cholangiography as I use it is part of the operation itself. It provides a degree of diagnostic precision such as has never before been attained by other exploratory means. Correct execution of cholangiography and the exact interpretation of the different roentgenographic images obtained become indispensable parts of the abdominal exploratory procedure and necessary requisites in deciding as to whether or not the abdomen should be closed without drainage after a cholecystectomy. This use of cholangiography is obviously so different from all other uses made of it that I propose to call it "operative cholangiography."

From the Faculty of Medicine, Córdoba, Argentina.

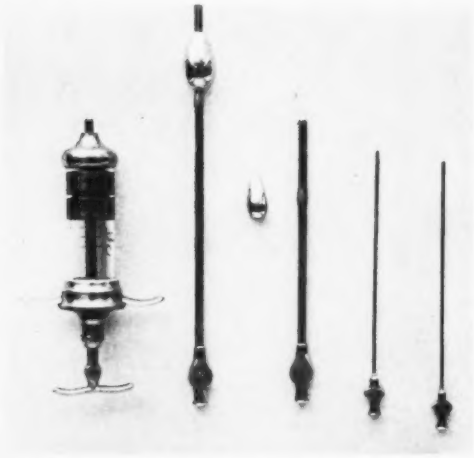

Fig. 1, from left to right: Ten cubic centimeter syringe. Cannula 14 centimeters long, the caliber of a No. 13 Charrière, with a 15 millimeter diameter olive tip; cannula 12 centimeters without 10 millimeter olive tip, which is at one side; needles for puncture of common bile duct, 1½ millimeter diameter; cannula of same caliber as the needle for catheterizing the cystic duct.

ADVANTAGES OF OPERATIVE CHOLANGIOGRAPHY OVER OTHER PROCEDURES

In order to formulate an opinion as to the condition of the principal bile passages, the surgeon has, apart from operative cholangiography, other factors upon which he can base his decision: (1) the pre-operative data, (2) the findings at operation, and (3) fistulography in the postoperative period. In the first group we have the clinical findings, the roentgenological study—both direct and after the injection of tetraiodine—in addition to the Graham-Cole method. In the second group we have intraperitoneal inspection and palpation, the mobilization of the duodenum and subsequent palpation, choledochotomy and instrumental exploration. In the third group we have a means of study through injection of opaque material through the drainage tube (gall bladder or common bile duct) or through a fistulous tract.

Pre-operative information. As to the clinical findings, every surgeon and physician has had many opportunities to observe the lack of relationship between symptoms and anatomical lesions in the bile passages. Some patients give a history of having had hepatic colic and jaundice, sometimes extending over long periods of time, but in them the principal bile passages seem to be completely free from obstruction, either calculous or mechanical. In other patients gall stones are found associated with spasm at the level of the sphincter of Oddi or with anatomical obstructions in the termination of the common bile duct; in such patients there will be noted a periodical regression of the canalicular defects. Some patients give a history of painful intermittent crises, without fever or jaundice, which suggests chronic cholecystitis, but careful exploration reveals the presence of gall stones and dilatation of the bile passages. Even in the much discussed question of jaundice, whether of hepatic or mechanical origin, in spite of the possibility in the great majority of cases of solving the problem by means of clinical examinations and study of the function of the liver, there are cases in which doubt remains—the patient's condition becomes aggravated and it becomes necessary to clear up the diagnosis.

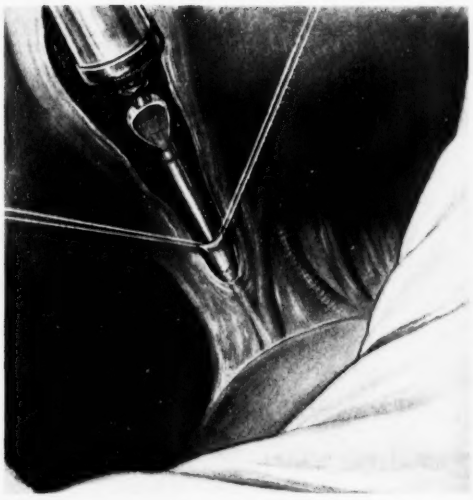

Fig. 2. The cannula 12 centimeters long and the caliber of a No. 13 Charrière is inserted into the cystic duct which is held on 2 loops of thread. It will be observed that the cannula enters only the proximal one-third of the duct.

Fig. 3. Taken from an actual case of sclero-atrophic gall bladder, in which a stone was found embedded in the proximal third of the cystic duct. Against the resistance of the stone, an opening was made with the point of the knife to allow the passage of a cannula 1.5 millimeters in diameter.

Direct roentgenography before operation rarely gives data of importance in the study of the principal bile passages except that calculi or concretions located in the gall bladder and common bile duct are occasionally visualized (14). Personally, of the hundreds of cases observed, in only 1 have I visualized stones in the common bile duct by means of direct roentgenography, so that I have come to believe that this procedure cannot be

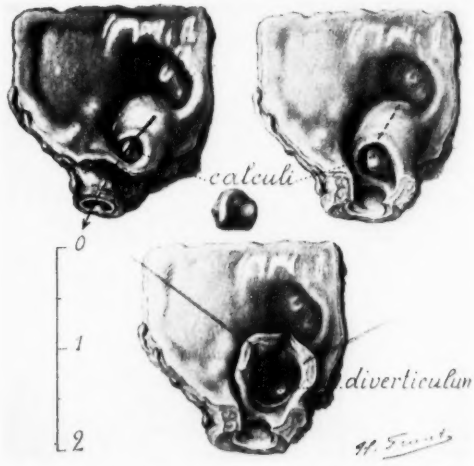

Fig. 4. Diverticulum formation in the proximal third of cystic duct, the inner wall of which had to be incised, while it was held in the hand, in order to extract a calculus the size of a hazelnut. (Drawing made from the actual organs.)

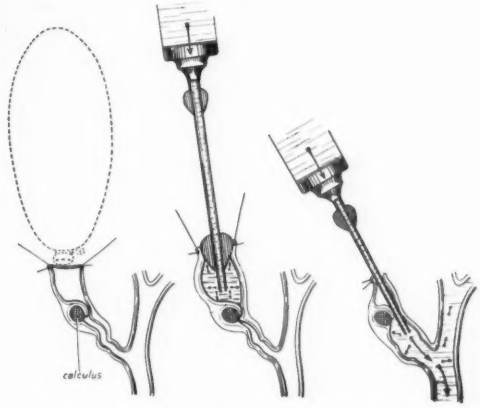

Fig. 5. Diagram to illustrate the condition in case shown in Figure 4. The second drawing shows the disadvantage that would be obtained by injecting above the obstacle. In the third drawing the cannula has passed by the obstacle, making it possible to inject the lipiodol.

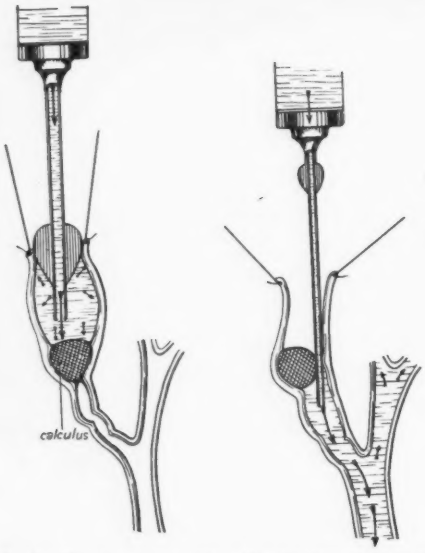

Fig. 6. Diagram representing the situation which arises when a calculus is intimately embedded in the wall of the cystic duct; the mobilization might rupture the duct or produce fragmentation of the stone.

relied upon. Roentgenographical study, in conjunction with the method of Graham-Cole, has made possible the visualization of the common bile duct in some pictures obtained in the course of cholecystographic examination of asthenics (3).

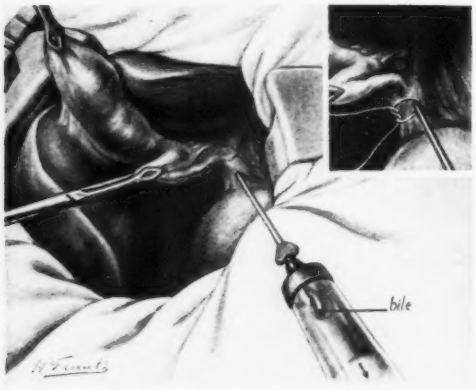

Fig. 8. The vestibule of the gall bladder is pulled upon with a Grégoire forceps. The needle has punctured the common bile duct and is within the lumen of the duct, indicated by the drop of aspirated bile in the syringe. In inset, method of transfixion to obliterate the opening before withdrawing the syringe after injecting the lipiodol.

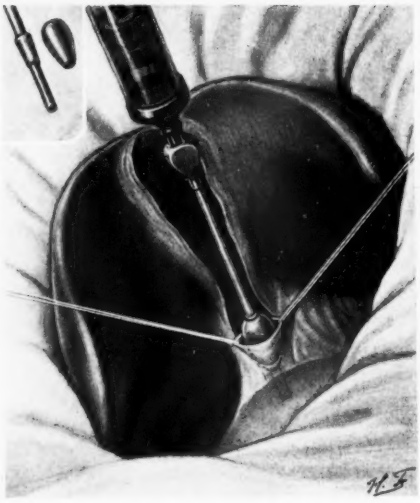

Fig. 7. The olive tip is fitted to the cannula when the cystic duct is dilated. In inset the olive tip is shown separate from the cannula.

However, we cannot count upon this source of information as far as the pathological condition of the ducts is concerned.

Operative information. Palpation of the common bile duct in the course of laparotomy is effective in thin subjects, especially to locate concretions of some size situated in the most accessible part of the duct. In the stout subject, if the pancreas is large, small calculi in the inferior third of the com-

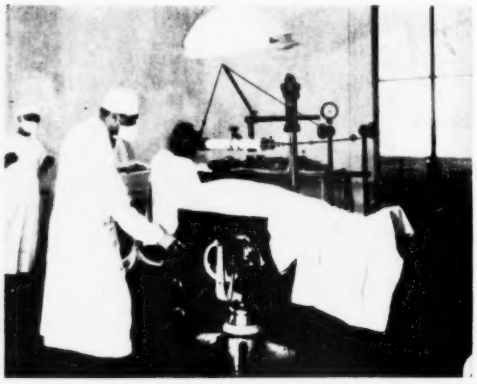

Fig. 9. Operating theater showing special arrangements. The patient is on the Potter-Bucky diaphragm and is covered with a sterile sheet. The radiologist is ready to put into use the portable x-ray apparatus.

mon bile duct or in the papilla of Vater easily pass undiscovered. It is necessary also to be forewarned against the possible existence of neighboring calcified nuclei which may lead one to do a useless choledochotomy. In obese women, the superabundance of fatty tissue makes palpation of the hilum of the liver and neighboring regions difficult. The fatty tissue in these patients lessens the sensation that foreign bodies might give, and the surgeon, through the negative information obtained by digital examination, fails to discover calculi in the principal bile passage. The exploration is more difficult if adhesions exist, if the pancreas is increased in size, and if the liver is hidden beneath the costal arch.

As to duodenal mobilization, it has been suggested that palpation be done after the duodenum has been mobilized, following the Kocher technique. This operative procedure can be done without inconvenience in some cases; it is true, however, that in precisely those patients in whom it would be of the greatest help, difficulties are met. Obesity, adhesions, a deep seated organ, and friability of tissues, make duodenal mobilization difficult. Moreover, it should not be forgotten that in patients in a precarious general condition the dislodgment of viscera increases shock and the possibility of postoperative complications; an operation free from brusque and traumatizing maneuvers should be chosen.

Choledochotomy followed by instrumental exploration is much safer than simple palpation. This has been advocated when the hepatic duct has thickened walls and is dilated. It is not always possible to be sure of these details, but in a normal supraduodenal common bile duct, this finding does not preclude the existence of concretions in the distal third of the duct. It is clear that choledochotomy does not lead to ill effects when the duct is of greater diameter than normal; but incision of a normal duct is more serious in that it may lead to stenosis.

As already stated, choledochotomy, recently freely used, is, without doubt, a richer source of information than simple palpation. Still, one must agree, and in this surgeons of great experience are of the same opinion, that in exploring the hepatic and common bile ducts, it is possible to slip alongside a calculus without the metallic sound detecting it; in the same way it is impossible to recognize intrahepatic concretions. Furthermore, even though some calculi have been removed, it is impossible to be sure that all have been removed, and here again, as foreign bodies are easily displaced and as the exploring sound may slip by the side of the calculus passing into the duodenum, we may have the erroneous conviction that no obstacle exists. A review of the many articles dealing with the postoperative study of such cases by means of lipiodol injection in order to discover overlooked concretions, will convince one of this.

Also it is true that if there exists a partial or complete obstruction due to pancreatitis, it is impossible to be sure of its nature, for the instrument may pass with difficulty or may be detained.

In dealing with stenosis of the principal bile passages, I will not omit recent discoveries. Vivisection and the study of the results of operations upon the bile passages are concerned especially with the sphincter of Oddi. The rôle played by this muscular ring in the principal syndrome of the right hypochondrium with or without jaundice, is important. It is of particular interest to the surgeon to know whether stricture of the papilla of Vater has an anatomical underlying cause—that is, an inflammation of the sphincter of Oddi, or if the stricture is simply a result of *temporary spasm* caused by irritation. When an instrument overcomes with some difficulty the resistance offered by the papilla of Vater, the impression is gained that stricture is present but the impression is not sufficiently accurate to affirm whether the stricture is of an anatomical or functional nature. It is absolutely necessary that the surgeon determine this point for it is on this factor that he will base his treatment: in the case of spasm it will be sufficient to eliminate the local or distal cause of the spasm, while in the case of stenosis or obstructing inflammatory condition in the sphincter of Oddi, deviation of the bile will have to be considered. Furthermore, it is possible for the point of the exploring instrument to enter a cul-de-sac and the impression is given that instead of passing through a permeable papilla, a stenosis is met that does not really exist.

Gentle exploration, of course, if it reveals nothing, has no other untoward effect than that of a useless preliminary choledochotomy; if it is ruthlessly done, however, it may traumatize the pancreas, causing grave complications. All maneuvers in the vicinity of the papilla of Vater predispose to acute hemorrhagic pancreatitis (Schnitzler-Walzel). Doppert observed in Schnitzler's clinic 5 cases of postoperative pancreatitis in 50 operations upon the bile passages; 4 were confirmed at autopsy. The author concludes that any traumatizing manipulation at the level of the transpancreatic portion of the common bile duct and the ampulla of Vater is apt to produce pancreatitis. Here is a further reason, based on the immediate result, for making us hesitant and prudent about the use of instrumental exploration near the head of the

pancreas—the region least accessible to the palpating hand and exhibiting factors likely to produce untoward consequences.

Postoperative cholangiography. The injection of lipiodol or some like medium through a fistula or drainage tube after operation is indicated when it is desired to determine the permeability of the biliary network. It is done when the condition of things has changed since operation.

Anatomical or functional lesions are susceptible to modification through simple drainage, and in surgery of the bile passages in order to eliminate the possibility of recurrence of the obstruction in the distal portion of the common bile duct, even when there exist well founded hopes that cholecystectomy will give relief, it is necessary that the exact intensity and nature of the lesions be appreciated during the operation itself. If this knowledge is lacking there is the risk that it may be too late to give relief when the changes have been discovered. Kehr's drainage and common bile duct fistula, more than cholecystectomy, create functional conditions which differ somewhat from those present at the time of operation. This regressive action, which is favored by external deviation of the bile, is especially true in the presence of spasmodic derangements of the sphincter of Oddi, of incipient strictures of the papilla of Vater, and of beginning stenosing pancreatitis. In Professor Haberer's clinic, examples have been known in which external choledochoduodenostomy had been performed in spite of the fact that by means of the T-tube permeability of the papilla was found. These were cases of stenosis due to inflammation of the sphincter of Oddi, in which the stricture of the papilla of Vater and lack of contractility of the hepatic and common bile ducts were the factors producing biliary stasis and made necessary a second, plastic, operation in order to give relief (18).

No one can ignore the importance of this means of discovering overlooked concretions or for ascertaining whether the anatomical stenosis is of the papilla of Vater or the result of pancreatitis, all lesions for the recognition of which manual or instrumental exploration has been found insufficient or impotent. It is also indisputable that to correct such errors it is necessary to perform a second operation which in the majority of cases is difficult and beset with trouble.

INTRINSIC ADVANTAGES OF OPERATIVE CHOLANGIOGRAPHY

Other authors have recognized the importance of operative cholangiography as a means of studying the principal bile passages and have recommended its application.

Recently I called attention to the usefulness of cysticoduodenostomy (9, 11, 13) in incomplete obstruction, either functional or anatomical, beyond the excretory ducts, by which internal secretion is maintained and the tone of the hepatic and common bile ducts is conserved. These lesions are recognized as such by means of operative cholangiography, thus making possible the institution of a physiological therapeutic measure, based on the conservation of an anatomical structure, the cystic duct, which would be sacrificed in the course of cholecystectomy as usually performed.

In studying the functions and the anatomical conditions of the bile passages, operative cholangiography is of great help; it gives a scientific basis for closure without drainage after cholecystectomy. The bile in the peritoneum observed by surgeons who believe its presence is due to slipping of a ligature, in most cases is testimony that there is an anatomofunctional lesion of the hepatic and common bile ducts that has not been noticed because of the inaccuracy, deceptiveness, and lack of precision in the methods of exploration used. Bile in the peritoneum may also be caused by a supernumerary duct, which generally opens into the hepatic surface of the gall bladder. Indeed, observation of the bed of the gall bladder during the lipiodol injection disclosed that small drops leave the cut duct, which is ligated like any vessel.

Operative cholangiography makes possible the recognition of non-calculous obstacles in the termination of the common bile duct (spasm, inflamed sphincter of Oddi, pancreatitis); it makes more precise the indications for cysticoduodenostomy. Operative cholangiography has placed cysticoduodenostomy among the preferred therapeutic measures in the treatment of gall-bladder disease.

Operative cholangiography gives precise information even as to the smallest stones at the papilla of Vater; it is this location which harbors the highest percentage of overlooked calculi.

Intrahepatic calculi also are difficult to find with other methods of examination and it is the opinion of surgeons of authority that operative cholangiography is the method which offers the greatest chances of locating such stones. Santy and Mallet-Guy say, "La cholangiographie au cours de l'opération, telle que Mirizzi l'a conçue est pratiqué sur une large échelle, nous paraît aussi trouver dans l'étude de la lithiase des voies biliaires intrahépatiques une particulière justification" (15). In my private records I have examples of intrahepatic calculi which were recognized through operative cholangiography. These cases are evidence of the truth of the assertion of the

Lyons surgeons. One of the great advantages of operative cholangiography is that with it it is possible to study carefully the condition of the bile passages before and after the extraction of the calculi and to determine the true condition of the common bile duct; thus secondary operations are avoided.

Without investigation with lipiodol in the ways advised, it is difficult to recognize pancreatitis and obstructive inflammatory disease of the sphincter of Oddi, in association with stones in the common bile duct. My experience has shown that pancreatitis and inflammation of the sphincter of Oddi in the presence of stones above the stricture are more frequent than is believed. In such cases recurrence of the stones is no strange event, if special attention is not paid to the anatomical lesion at the distal portion of the common bile duct (12).

Operative cholangiography makes orientation possible when the pseudotumoral form of cholelithiasis is encountered. In these cases the hepatic space is blocked by a mass formed by agglutination and the firmly adherent organs. The surgeon is in doubt as to whether he is dealing with a neoplasm or an inflammatory condition, especially if jaundice of the obstructive type is present. If one is fortunate enough to locate the gall bladder by puncture and to extract bile, operative cholangiography, after the injection of the lipiodol into its cavity, will give very useful information which will help in making a decision as to the proper treatment.

The precise information furnished with operative cholangiography makes it possible to limit manipulation to a great degree, only strictly necessary procedures being done, thus giving maximum security. We all know how difficult manual exploration is, especially in men—the rigid thorax, the liver in retroposition, a blocked subhepatic space, a sclerotic and atrophied gall bladder, pancreas generally enlarged, and the greater depth of the hypochondrium, all of these factors tend to make manipulation more difficult; furthermore, every day experience confirms the great seriousness and the higher operative mortality in man (17, 19).

From the point of view of technique, investigation of the common bile duct is simplified, because the injection of lipiodol through the cystic duct diffuses and distends the stenosed bile passages in the pancreatico-duodenal portion, which is revealed as being distended, standing out in relief in the hilum of the liver; under these conditions incision presents no difficulty and operative accidents are avoided.

UNJUSTIFIABLE OBJECTIONS

In my service operative cholangiography is carried out during operation in all operations upon the gall bladder and the bile passages. The method is entirely innocuous; a fact that is proved by its use in 400 patients operated upon on my service without any inconvenience whatever.

It has been objected that lipiodol may be the bearer of micro-organisms. If the present ideas regarding infection of the bile passages are borne in mind, this fear is unfounded. My personal experience has demonstrated that there are no bad effects from this standpoint; I have used operative cholangiography in all cases of suppurating angiocholitis and have had no ill effects from its use.

Lipiodol has been thought to produce toxic phenomena. I wish to emphasize that the quantity of lipiodol I inject is minimal; the pressure used is insignificant and one might say that the substance penetrates spontaneously.

It has been argued that operative cholangiography prolongs the operation. It must not be forgotten that in many cases the future welfare of the patient depends upon these few minutes of waiting. Remember the great benefits obtained in surgery of the nervous system, in the meticulous technique of gastrectomy as followed by the Austrians and the Germans, and in the careful execution of thyroidectomy for exophthalmic goiter; all these afford sufficient basis for recognizing how valuable is a patiently, carefully performed operation. The bile passages deserve no less careful treatment.

The objection has been raised that operative cholangiography requires the use of local and regional anesthesia. To my mind, far from being an inconvenience, this is a great advantage. By avoiding general anesthesia, which is badly tolerated in obese patients, postoperative complications are less frequent. Everyone agrees that, thanks to local and regional anesthesia, operations on the bile passages have lost their gravity, and operative mortality has been greatly lowered.

Naturally, when the patient presents some nervous disorder (hysteria, epilepsy, etc.) or when the glands of internal secretion are not functioning normally (tetany, hyperthyroidism), general anesthesia is indispensable. In such patients one must be satisfied with palpation of the passages and choledochotomy; moreover, there remains the recourse to cholangiography, the lipiodol being injected through the drainage tube in the common bile duct.

On my service, in the few patients who were frightened at operation or who were very sensitive, it has been possible to inject lipiodol directly

into the cystic duct or into the gall bladder under regional anesthesia so that the surgeon or radiologist could accomplish all that was necessary when the occasion arose.

TECHNIQUE

Material required. A glass 10 cubic centimeter syringe is used for the injection of the lipiodol. The syringe has a metallic piston which is provided with a screw stem. The beak of the syringe must be adaptable to the cannula or needle, as required. Three cannulas are necessary: Two to have the caliber of a No. 13 Charrière, one 12 centimeters and the other 17 centimeters in length; the third cannula is of the same diameter as the needle, 1.5 millimeters. When it is necessary to produce a hermetically tight connection while using a cannula of large caliber, in cases of dilated cystic ducts, an olive shaped adapter, 10 to 15 millimeters in diameter, can be fitted to the end of the cannula (Fig. 1). A bottle of 40 per cent lipiodol is part of the equipment.

Technique of injection. The injection of the contrast substance can be made (a) into the gall bladder; (b) through the cystic duct; (c) after puncturing the common bile duct.

Injection into the gall bladder is indicated when it is inadvisable to mobilize a gall bladder, the cavity of which has not been cut off from the bile passages. Lipiodol, to the amount of 10 to 20 cubic centimeters, is injected into the body of the gall bladder after the bile has been aspirated. The point of puncture must be ligated when the needle is withdrawn. Light pressure is sufficient, in cases free from concretions and with elastic walls, for the lipiodol to flow into the bile passages; in other cases in which the walls of the gall bladder are like cardboard and the cystic duct is dilated, the flow of the lipiodol is rapid and spontaneous.

This technique has made it possible in some cases to determine the hepatic origin of jaundice when the clinical and laboratory investigation did not solve the question. It was possible also in certain cases of jaundice due to sluggishness in the principal bile passages, to make the diagnosis with certainty. Injection of the gall bladder is indicated in the pseudotumoral form of lithiasis, in which all the organs form one subhepatic block and only the tip of the gall bladder is accessible. Naturally, permeability of the cystic duct is essential; easy and abundant aspiration of bile indicates that the organ has not been occluded.

Injection through the cystic duct. In all those cases in which cholecystectomy must be done, I pay particular attention to the dissection of the vestibule and the cystic duct, because, by this route, almost all the injections are made. Four different varieties of cystic ducts may be found: (a) those of normal and catheterizable caliber; (b) those of normal caliber but in which catheterization is difficult; (c) those obliterated by scar tissue or calculus; (d) those which are dilated.

In the normal cystic duct, injection is done with the cannula without the olive tip. A part of the vestibule is always systematically left and this is held by two loops of thread while injection is made.

In the second type, the difficulty is due almost always to the Heister valves which become most fully developed in the vestibular extremity. It is sufficient in these cases to use the fine cannula, which will pass the obstruction and will not rupture the gut. For example, in a thin walled cystic duct, the ordinary cannula with the olive tip was inserted. The lipiodol did not pass the first part of the cystic duct which indicated that the delicate wall would burst if the process of injection were persisted in; the proximal one third was catheterized with the fine cannula, the injection then being made without difficulty. We congratulated ourselves on having made use of this means because it was possible with it not only to make a cholangiographic examination but also because we finally had to perform a cysticoduodenostomy as we were dealing with a difficult case of sluggishness (dyskinesia) of the principal bile passages (Huenz, Sanatorio, operated upon August 22, 1933, Case 55, third series).

Obliteration of the cystic duct by scar tissue is exceptional. In my series of cases it occurred in only 2 per cent of the cases. The obstruction is rarely near the opening of the cystic duct; usually it is found near the vestibular extremity of the duct. One should not be surprised when, in some cases, the duct is apparently obliterated and yet appears to be permeable when the first drops of lipiodol are injected; because of the action of the lipiodol the walls "unfold." When the obstruction is in the first part of the cystic duct, a small opening below the stricture is made with the point of a knife. The opening is made sufficiently large to allow the passage of a fine cannula (Fig. 3); if the obstruction is proximal to the puncture wound in the duct, there is no alternative but to puncture the common bile duct.

Obliteration of the cystic duct by stone is frequent and generally caused by only one stone. It is not unusual, however, to find stones in line in the duct. In these cases the gall bladder may or may not have been extirpated. When the gall bladder has not been removed, a small opening is

made just below the calculus, large enough to allow the passage of a fine catheter (Fig. 3). When the injection is completed care must be taken to avoid regurgitation of the lipiodol by closing the small opening by means of a fine thread suture, with a fine needle. When the gall bladder has been extirpated, the stone can be removed from the duct by gentle maneuver; if resistance is encountered, it is inadvisable to be too strenuous because of the risk of traumatizing the walls of the duct or of breaking the stone, thus facilitating the passage of fragments into the common bile duct. On the other hand, it is difficult to determine whether the immobility of the stone is due to its being closely embedded in the walls, to the valves of Heister, or to the presence of a real diverticulum (Fig. 4); the most practical thing to do is to pass a fine cannula to one side of the stone and make the injection (Figs. 5 and 6). A ligature is provisionally made after the injection at the level of the vestibule.

In the fourth type, those in which the duct is dilated, the olive tip is fitted to the No. 13 Charrière cannula to avoid regurgitation of the lipiodol (Fig. 7). This technique is also followed when the gall bladder is sclerotic and atrophied. In such cases the cystic duct is often so short as to be confused with the vestibule, and the impression is gained of the latter opening directly into the common bile and hepatic ducts.

Puncturing the common bile duct. Thin, elastic walls in the common bile duct are unfavorable for puncturing. Friability favors tearing and enlargement of the orifice made by the needle; injection of lipiodol carries with it the risk of infiltrating the cellular tissue at the hilum of the liver. Fortunately, puncture is usually made in dilated ducts which have solid and thickened walls; puncture is preferably made without stripping the peritoneal covering from the duct, especially if the walls are thin.

Visibility of the duct is improved if one takes the precaution of gently pulling upon the vestibule with a Grégoire forceps. Puncture is made with the needle mounted on the syringe nine-tenths full of lipiodol; the object of leaving a space empty is to facilitate aspiration of bile, thus making it more certain that correct insertion of the needle has been made (Fig. 8). When we are certain that the needle is within the common bile duct, the lipiodol is injected at once. Before the needle is withdrawn, a fine needle with linen thread is used to obliterate the tiny orifice, by transfixion (Fig. 8). This detail is important, especially in those cases in which the common bile duct is surrounded by lax cellular tissue, a circumstance facilitating the diffusion of the lipiodol immediately after it escapes through the perforation.

Precautions and dosage. As a general rule, it must be remembered that the better the tone and activity of the bile passages, the slower and smaller the injection will be. In a common bile duct of normal diameter or slightly dilated and with elastic walls, if more than is necessary is injected, the risk is run of producing spasm in the papilla of Vater or of favoring purely mechanical penetration into the duct of Wirsung. Naturally all these accidents and errors are easily avoided by injecting the lipiodol slowly and in small quantities. In general we inject at the rate of 1 cubic centimeter of lipiodol per minute, when injecting through the cystic duct. In cases in which there are no advanced anatomical changes, 3 or 4 cubic centimeters is injected; this is a sufficient quantity for studying the principal bile passages. The injection is always made slowly—the screw on the stem of the piston helps to do this; the slowness of the injection and the action of Heister's valves, which neutralize all excess pressure, must also be relied upon. With these precautions one can be assured that the lipiodol penetrates spontaneously the principal bile passages, thus making it possible to secure precise data regarding the anatomy and function of the excretory passages.

During the injection into the cystic duct, into the middle third of which the point of the cannula is inserted, the bed of the gall bladder is examined as well as the distal third of the cystic duct and the junction of the ducts. The presence of an abnormal bile duct or of a solution of continuity produced during the operation is recognized by the escape of drops of lipiodol. It is logical that, when the common bile duct is visibly dilated, or when there are evident signs of obstruction, the nature of which is to be determined, 10 to 15 cubic centimeters of lipiodol is injected; the same quantity is used when the injection is made into the gall bladder.

Technique of verification. To verify the condition of the bile passages, we find out if, after removing the stones in the hepatic and common bile ducts, there remain overlooked calculi. For this purpose, after a T tube is inserted in the common bile duct and the choledochotomy opening is narrowed, a quantity of lipiodol, depending on the capacity of the bile passages, is injected through the T tube. It should be remembered that the object is to see the entire extent of the bile passages, extrahepatic and intrahepatic. I have injected as much as 40 cubic centimeters of lipiodol after the stones have been extracted from

the common bile duct, in patients with jaundice and in a delicate condition, without the least ill consequences.

Roentgenography. In my service, a high tension cable is brought from the X-ray cabinet to the operating theater. The Coolidge tube is placed on an L-shaped support, movable in all directions, or a portable apparatus may be employed. The patient is placed on the Potter-Bucky diaphragm and is covered with a sterile sheet (Fig. 9).

All instruments that might intervene between the tube and the film are removed. Generally 2 roentgenograms are sufficient with an interval of 10 to 15 minutes between exposures; sometimes only one is enough. To obtain a clear image, *absolute immobility of the right hypochondrium* is essential—this can be secured because of the fact that the patients are operated upon under local anesthesia. In this way, without loss of time, the radiologist takes the roentgenograms he finds necessary, they are developed in the laboratory close by, the films are examined immediately on a roentgenogram illuminator in the operating theater, and the operation is proceeded with in accordance with the findings in the roentgenograms.

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EDITORIALS

SURGERY
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NOVEMBER, 1937

FRACTURES OF THE NECK OF THE FEMUR

THE treatment of fractures of the neck of the femur has entered a new era. Two factors are responsible for this: (1) the use of the lateral x-ray and, (2) the use of internal fixation. Lateral x-ray views have taught us that certain of the so called impacted fractures are not impacted at all but are in distinct malposition and are even overlapped. Thirty years ago Whitman showed that bony union could be obtained in the majority of cases, but the long fixation in a cast, an essential part of the treatment, meant a tedious and confining convalescence that led to stiff knees and hips discouragingly slow to respond to treatment. Internal fixation shortens the period of immobilization and stiff joints cease to be a problem.

Smith-Petersen's paper, wherein he advocated nailing the fragments with a triple flange nail, was not published until he had a sufficient number of proved good results to show that internal fixation was feasible, practical, and safe. He originally advised opening the hip joint, a formidable operation but one necessary in inserting a nail unless some means is used to determine definitely the proper line for such insertion. Various instruments and gadgets have been devised to determine the line of insertion, but a practical and accurate method is the threading and insertion of a cannulate nail or lag screw on a guide wire, the position of which has been previously determined by anteroposterior and lateral x-ray films. This renders exposure of the joint unnecessary.

However, even if the mechanical requirements of reduction and fixation are fully complied with, there is still a "nigger in the wood pile," so to speak. This has to do with the blood supply of the head of the femur. It has been shown that the blood supply of the head of the femur is in a large measure carried to it by the artery which comes from the internal obturator vessel and finds its way beneath the cotyloid ligament to the ligamentum teres and along it to the bone. But, unfortunately, in approximately 20 to 25 per cent of adults this blood vessel is either lacking or is so minute that it fails to deliver enough blood to be of any use. This explains the atrophic changes, with flattening and distortion of the head, in a certain percentage of cases following perfect reduction, fixation, and even the attainment of bony union. Such changes develop 6 months or a year after union, and nothing can be done about it because there is no way of knowing beforehand whether or not this blood supply through the ligamentum teres is present or not. While it is true that femoral heads without this blood

supply will unite to the neck of the femur in a fair percentage of cases when the fracture is correctly reduced and held in place, nevertheless such a faulty blood supply must account for a considerable percentage of non-unions. The prognosis as to function in all fractures of the neck of the femur must therefore be guarded no matter how successful the reduction and fixation. It takes at least a year to determine whether or not atrophy of the head will develop.

MELVIN S. HENDERSON.

VISION IN SURGERY

TECHNICAL skill in diagnosis and treatment is usually admitted as a virtue of specialism. Much of the emphasis in training for specialists in surgery is laid upon the development of unusual dexterity in manipulative and mechanical methods for arriving at the patient's exact condition and for his relief. However, there always arises incidentally, or should arise, a special kind of perception by means of which the really skillful surgeon can accomplish more by understanding the possibilities of improving his patient as well as by carrying out the details of his diagnosis and surgical care. In a patient with infantile paralysis, for example, the prevention of deformity as well as opportunities for the later use of weakened limbs should be appreciated. Braces and surgical operations for the stabilization of flail joints must be understood to make surgical plans for the patient's future. This applies not only to the specialist but to any physician or surgeon examining such a child, so that even if such treatment is not suggested it will at least not be neglected or criticized through lack of understanding. The failure to understand these possibilities often results in a refusal of such treatment and patients drift about from one practitioner to another or fall into the hands of irregulars and quacks because correct treatment has not been suggested or explained.

By combining an unusual initial insight into the patient's possibilities with the other attributes of specialists it is possible to arrive at a certain kind of successful result not obtainable otherwise for many surgical conditions.

This phase of the functions of a specialist is not generally appreciated. It is not always employed by the specialist himself. The true surgeon should perceive in the patient as he presents himself certain possibilities that are not discerned by the average practitioner or by the inadequately prepared surgeon who assumes a specialty for which he is immature. One may illustrate by taking the matter of an x-ray plate—the x-ray diagnostician reads a plate not strictly according to the contents of the film itself but according to the training and experience which he puts into the reading. One sees on an x-ray plate not actually what is there, but what he has been trained to see or what his experience in x-ray reading enables him to distinguish with the plate before him. Accordingly, the patient obtains from his x-ray diagnostician a reading which does or which does not lead to correct diagnosis and treatment as far as the x-ray diagnosis is concerned.

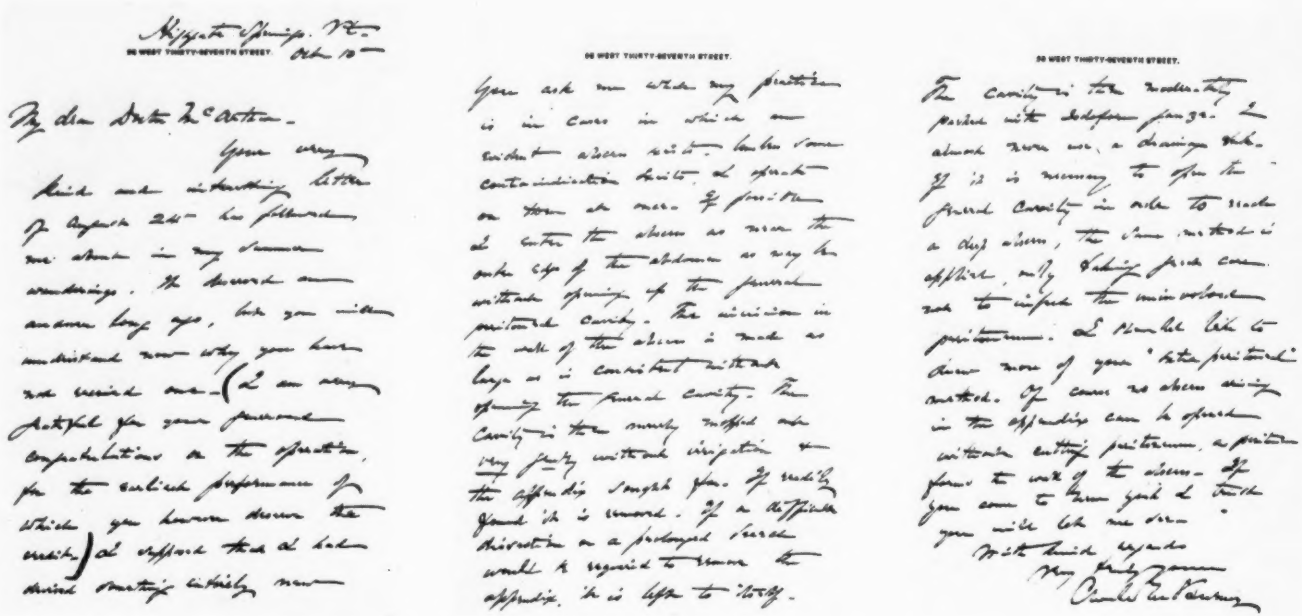
It is exactly so in observing patients. The inadequately trained surgeon sees in the patient as he presents himself not necessarily the possibilities that actually exist, but only those possibilities which his training and experience enable him to perceive.

Criticism of specialists by general practitioners often arises in this way. The general practitioner has been able to see neither the patient's condition in its true light nor the

possibilities for remedy or relief. In arthritis, for example, practitioners generally and even medical and surgical specialists without experience in the mechanical prevention of deformity or its surgical correction, sometimes fail to recognize possibilities for the prevention and cure of deformity that would save much permanent disability. The same comment applies with even greater force to the secondary treatment of fractures in patients with poor results following primary treatment. Failure to comprehend the patient's actual condition and his possibilities lie along with an unfamiliarity with the technical methods by which the treatment is to be carried out and ultimate results are to be obtained.

Those surgeons of experience and training who look upon their specialty as one in which fairly accurate mathematical degrees of diagnosis may be made and results obtained, are those who have the vision as well as the technical skill to apply to each problem all the methods essential for success. This constitutes the sort of surgical equipment that should characterize everyone who hopes to make a success of the practice of any specialty and of surgery in particular.

H. WINNETT ORR.



Facsimile of letter from Dr. Charles McBurney to Dr. Lewis L. McArthur, dated October 10, 1894.

LANDMARKS IN SURGERY

THE MUSCLE-SPLITTING OR GRID-IRON INCISION FOR APPENDECTOMY

An Historical Note

SELIM W. McARTHUR, M.D., Chicago, Illinois

IN VIEW of the world-wide adoption of the muscle-splitting abdominal incision as an approach for appendectomy, and in view of the numerous references in the current literature as regards the importance of this incision, in the lessened mortality rate, diminished period of hospitalization and freedom from postoperative hernias, a brief note of certain facts concerning the historical origin of this incision may be of interest.

In the spring of 1894, Dr. Lewis Linn McArthur of Chicago, made application to the secretary of the Chicago Medical Society for a place on the program at a regular meeting to present an original contribution by him concerning a new method of incising the abdominal wall, especially applicable to appendectomies. Originally, he was assigned a place on the June, 1894, program, but due to the length of the program, and the fact that his paper was the last on the list, Dr. McArthur agreed on request to postpone his presentation until an early fall meeting of the society.

In the *Annals of Surgery*[1], July, 1894, appeared an article entitled "The Incision made in the Abdominal Wall in Cases of Appendicitis, with a Description of a New Method of Operating" by Dr. Charles McBurney, surgeon to the Roosevelt Hospital of New York. In this article, Dr. McBurney describes the typical muscle-splitting incision as now so widely used. He reports having used this method in 4 cases "of recurrent appendicitis," the first having been done on a patient on December 18, 1893, or about 6 months prior to this presentation of the method. He qualifies his recommendation for the use of this method of incision by the statement, "This operation does not appear suitable for cases accompanied by suppuration about the appendix, which require extensive packing with gauze." And in conclusion remarks, "Sufficient time has not elapsed to justify me in presenting the final results as positively an improvement upon those obtained by older methods."

On reading this paper in the *Annals*, Dr. McArthur immediately wrote Dr. McBurney on August 24, 1894, congratulating him upon his essay and enclosed a copy of his own paper on the same subject, which at the time had not been as yet presented.

[1]Vol. 20, p. 38.

In reply, Dr. McBurney wrote Dr. McArthur a cordial letter dated October 10, 1894, apologizing for delay in answering because of absence from home and in this letter graciously acknowledges the fact of Dr. McArthur's priority of use of this method of abdominal incision. In addition, some years later, at a dinner in Chicago, given to Dr. McBurney, he again publicly acknowledged the same to his Chicago colleagues. This, of course, does not appear in print. The aforesaid letter from Dr. McBurney was discovered in November, 1934, among the correspondence in the desk of Dr. McArthur at the time of his death. This letter is now deposited at the John Crerar Medical Library in Chicago for simple historic interest, and for similar reason, there follows here a true copy of the letter.

Highgate Springs, Vt.
October 10, 1894.

My dear Doctor McArthur:

Your very kind and interesting letter of August 24th has followed me about in my summer wanderings. It deserved an answer long ago, but you will understand now why you have not received one—I am very grateful for your generous congratulations on the operation, for the earliest performance of which you however deserve the credit—I supposed that I had devised something entirely new and your letter to me is the first intimation I have had that the operation had even been done by anyone but me. But in these days when active clever workers are so numerous the opportunities to devise anything entirely original are few and far between. I think the operation has hardly been appreciated even by those who have read the description—at least I have seen no comments upon it in the journals of my neighborhood. I think it is destined to supplant all other operations for the removal of the normal or of the chronically inflamed appendix. But who knows. You ask me what my practice is in cases in which an evident abscess exists. Unless some contra-indication exists, I operate on them at once. If possible I enter the abscess as near the outer edge of the abdomen as may be without opening up the general peritoneal cavity. The incision in the wall of the abscess is made as large as is consistent without opening the general cavity. The cavity is then merely mopped out very gently without irrigation and the appendix sought for. If readily found it is removed. If a difficult dissection or a prolonged search would be required to remove the appendix, it is left to itself. The cavity is then moderately packed with iodoform gauze—I almost never use a drainage tube. If it is necessary to open the general cavity in order to reach a deep abscess, the same method is applied, only taking great care not to infect the uninvolved peritoneum. I should like to know more of your "extra peritoneal" method. Of course no abscess arising in the appendix can be opened without cutting peritoneum, a peritoneum forms the wall of the abscess. If you come to New York I trust you will let me see

With kind regards

Very truly yours,
(Signed) Charles McBurney

Dr. McArthur read his own paper before the regular meeting of the Chicago Medical Society on October 1, 1894, at which Dr. Nicholas Senn, president, presided. The title of the paper reads "Choice of Incisions of Abdominal Wall, especially for Appendicitis," and it subsequently appeared in print in the *Chicago Medical Recorder* for November, 1894.

In prefacing his essay, Dr. McArthur mentions the fact that Dr. McBurney had already reported the same method, and that he, Dr. McArthur felt, this in itself was adequate recommendation for the method.

In this paper, Dr. McArthur draws attention to his having used the method in 59 cases, the oldest of these 3 years prior to this presentation. In contradistinction to Dr. McBurney's recommendation, he advocates the use of this type of incision in all types of appendiceal inflammation, suppuration, and abscess formation. And in passing, draws attention to the fact that similar principles of muscle fiber separation can and should be used in other areas of the body. In concluding his paper, Dr. McArthur sums up the recommendations for this method as having (1) less hemorrhage; (2) clear anatomy; (3) least possible danger of hernia; (4) if necessary to enlarge the wound, only one layer of muscle need be sacrificed; (5) less suturing; (6) patient need not be as carefully confined to one position; (7) less cellulitis.

The minutes of this meeting of the Chicago Medical Society signed by Junius Hoag, secretary (now deposited at the Chicago Historical Society) show the paper was discussed by Drs. John B. Murphy, Alex H. Ferguson, Arthur Dean Bevan, and Samuel Plummer.

An important item, apropos of the historical interest is the statement at the time of Dr. E. Wyllys Andrews, that he has used McArthur's method for several years with great satisfaction, and he was greatly impressed with the self closure of the muscle layers, so that frequently he had not inserted a single suture in them on closing the abdomen.

In conclusion, Dr. McArthur during the last years of his life, frequently expressed the opinion that this method of muscle fiber separation had been a real contribution to surgical technique from the standpoint of mortality and morbidity.

CORRESPONDENCE

CONGRESS OF UROLOGY, BUENOS AIRES, ARGENTINA

FROM November 28 to December 4, 1937, the Second American Congress and the First Argentine Congress of Urology will be held in Buenos Aires. The subjects for discussion are: genito-urinary hydatidosis, genital tuberculosis, urography of excretion, and endoscopic surgery of adenoma of the prostate. The president of the Congress is Professor Dr. Bernadino Maraini, Santa Fe 910, Buenos Aires.

SOME OBSERVATIONS ON ORTHOPEDIC SURGERY IN EUROPE

IN THE editorial appearing on page 1094 of the June, 1937, issue of SURGERY, GYNECOLOGY AND OBSTETRICS, Dr. Ralph Ghormley attributed an operative procedure for the treatment of fractures of the neck of the femur to Dr. Faldini of Parma. The credit for this procedure should have been given to Dr. Ettorre of Milan. Dr. Ettore first proposed subtrochanteric osteotomy for the treatment of fractures of the neck of the femur in old people in 1933 at the congress of the German Orthopedic Society. At the last congress of the International Orthopedic Society, to which Dr. Ghormley referred, it was Dr. Ettore, and not Dr. Faldini, who made the presentation of the patients operated upon by this method.

CARCINOMA OF THE COLON—A CORRECTION

IN THE article entitled "Carcinoma of the Colon" by Moses Behrend, the last sentence in the paragraph on anesthesia appearing on page 513 of the October, 1937, issue of SURGERY, GYNECOLOGY AND OBSTETRICS should read: "In somewhat over 3000 cases I have never had a death following the use of neocaine."

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE authors state that they have published their book, *Carcinoma of the Female Genital Organs*,[1] of some 215 odd pages because of the lack of any "work fully illuminating the question of carcinoma of the female sexual sphere." Malinowsky and Quater have obtained the contributions of some 9 other specialists in various branches of medicine to make it a more comprehensive work. The opening chapter is a general discussion of the pathogenesis and etiology of tumors under three main heads, namely, inciting, predisposing, and accessory factors. The authors discuss clinical and experimental data concerning the controversial question of "precancerous condition of tissue." They also point out the significance of the chronic irritation theory by Virchow in the development of tumors and confirm the fact that they may develop from implantation of embryonic tissue as stated by Cohnheim. The various and sundry irritants are discussed with their relationship to tumor development, and the statement is made, "the duality of the nature and etiology of tumors is beyond any doubt." They feel that heredity does have some influence on the appearance of tumors.

The next two chapters deal with the pathology and clinical picture of carcinoma of the uterus and mammary gland. The authors stress the importance of the classification of uterine carcinoma into cervical or that of the vaginal portion; endocervical or that of the canal; and that of the body or fundus of the uterus, because of the differences in rate and type of growth and metastases, although they state that for clinical purposes they divide only into two groups: carcinoma of the cervix and carcinoma of the body of the uterus. They discuss the pathology in relation to the development of various signs and symptoms in the patient.

In chapter four the authors present more rarely observed forms of carcinoma of the female genital organs, such as that of the ovaries, fallopian tubes, vulva, and vagina, including the Krukenberg's tumor. In the following chapter the question of metastases of carcinoma of the ovary is covered in detail.

Chapter six covers the surgical treatment of carcinoma of the uterus, giving several illustrations of technique, and discusses different methods of treatment including the Wertheim abdominal approach. In the next chapter the authors discuss the treatment of carcinoma of the uterus with radiant energy, namely radium and roentgen-ray, and bring out the various factors involved in the comparison of this method with surgical procedures. Chapters eight and nine bring out the various proposed methods of treatment of inoperable carcinoma, including the use of calcium salts.

Chapter ten is a discussion of carcinoma of the mammary gland including diagnosis, treatment, and prognosis. The authors stress the importance of differentiating between benign and malignant lesions.

In the final chapter the authors discuss carcinoma of the female sexual sphere in its relationship to economics and disability, and more specifically in its relationship to the insurance problem.

BYFORD F. HESKETT.

IN this relatively small text,[2] Dr. Carter, one of the younger cardiologists of Chicago, has attempted the difficult task of presenting the extensive subject matter of electrocardiography. A portion of the original material for this book, which has been amplified by the author, was published in the *Journal of American Medical Association* a few years ago. On the whole the book is somewhat too complicated for the beginning student of electrocardiography, and not sufficiently extensive for the trained cardiologist. The large number of electrocardiograms is representative, although many of the cuts are too small. The bibliography is rather well selected. One might question some of the author's terminology particularly the matter of right and left bundle branch block which is not in accord with the conclusions reached by the authoritative American Heart Association. Another point of disagreement is the matter of ventricular preponderance. The book has a number of satisfactory points.

C. C. MAHER.

THE first volume of Weibel's *Frauenheilkunde*[3] is a complete textbook on obstetrics, of 627 pages. The volume is very profusely illustrated with black and white as well as some unusually fine colored illustrations, and many clear roentgenograms, some of which have been advantageously retouched. The subject matter is sound and is presented in a direct, concise manner, reflecting the extensive knowledge and long teaching experience of the author. The book is printed on good stock well suited to the illustrations, in clear type interspersed with bold type for key-words and headings. An adequate and complete index is appended. The reviewer anticipates

[1] CARCINOMA OF THE FEMALE GENITAL ORGANS. By M. C. Malinowsky and E. Quater. Translated from the Russian by A. S. Schwartzmann, A.B., M.D. Boston: Bruce Humphries, Inc., 1936.

[2] THE FUNDAMENTALS OF ELECTROCARDIOGRAPHY INTERPRETATION. By J. Bailey Carter, M.D. With a foreword by Horatio Burt Williams, M.D., Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

[3] LEHRBUCH DER FRAUENHEILKUNDE. By Prof. Dr. W. Weibel. Vol. 1: GEBURTSHILFE. Berlin and Vienna: Urban & Schwarzenberg, 1937.

with pleasant expectancy the appearance of Weibel's companion volume, devoted to gynecology. The work is recommended to all students and practitioners of obstetrics. IRVING F. STEIN.

IN Arthur E. Guedel's *Inhalation Anesthesia*[1] we have at last a very practical guide for the student in anesthesia and for the experienced anesthetist. Dr. Guedel's principles of inhalation anesthesia have been used by many of us for years; the signs of anesthesia, as outlined by him, have been of maximum importance in guiding us through trying anesthesias.

This manual is practical, basic in its principles, concise, and brief in its delivery. It is hoped that Dr. Guedel will continue in his writings to give us the much needed complete text and reference book in anesthesia. MARY KARP.

IT is impossible in the present stage of our knowledge of endocrine physiology to do more than sketch the outlines of the subject, but a helpful, well documented presentation in one volume of clinical endocrinology is made by Werner in his recent book.[2] Necessarily the extent of the field covered makes the discussion of many subjects quite superficial. Any one of the many syndromes is worth a book in itself. Terms remain in use that the immediate future will disclose as inaccurate or misleading. Treatment is unsatisfactory and there is still the tendency to confuse the course of natural development with therapeutic results. A great amount of the material in such a book at this time must be regarded as controversial. The discrepancy between physiology and clinical medicine is painfully apparent in such an understanding. After a good discussion of the physiology of the pituitary, for example, the author describes so called bilobar pituitary disorders. The diagnosis at present is based on clinical interpretations rather than physiological tests. The confusion is twofold in that the clinical characteristics are of unknown origin, but they serve as the basis for a diagnosis which, in itself, seems to be a pure hypothesis. Nevertheless, in spite of these difficulties which are at present inescapable, the volume is valuable, worth studying, and suggestive.

PAUL STARR.

A MAGNIFICENT monograph[3] on ovarian function is that of Kehrer. The contents may be outlined as follows: (1) biologic-endocrinologic fundamentals; (2) physiologic amenorrhea; (3) pathologic amenorrhea; (4) the problem of ovarian function in monoglandular endocrine pathology, that is, (a) ovary, (b) diencephalo-adenohypophysis, (c) pineal gland, (d) thyroid, (e) parathyroid, (f) thymus, (g) liver, (h) spleen, (i) pancreas, (j) adrenal; (5) the problem of ovarian function in biglandular and pluriglandular diseases; (6) the problem of ovarian function in infantilism; (7) the problem of ovarian function in status lymphaticus; (8) the problem of ovarian function in spasmophilia; (9) the problem of ovarian function in obesity; (10) the problem of ovarian function in malnutrition; (11) the problem of ovarian function in systemic diseases; (12) the problem of ovarian function in skin diseases; (13) psychogenic amenorrhea; (14) ovarian function in psychoses; (15) ovarian function in central nervous system diseases; (16) results of failing ovarian function, especially climacteric and castration; (17) diagnosis of cause of amenorrhea; (18) prognosis in amenorrhea; (19) therapy of various forms of amenorrhea—(a) roentgen therapy, (b) surgical therapy, (c) hormonal therapy.

Each of these sections has several subheadings; each is considered in detail; constant reference to the literature is made. There are 50 closely packed pages of bibliography. An index is provided.

Needless to say, this volume will serve as a valuable reference work and an immediate aid to the gynecologist and endocrinologist. PAUL STARR.

POSTOPERATIVE and especially pre-operative care are too frequently neglected despite repeated reference to the subjects in current journal articles. A new work[4] by Dr. Robert L. Mason and collaborators provides excellent reference material on this subject. The reason for this seeming neglect may lie in the fact that the medical student is taught the fundamentals of the diagnosis of a specific lesion and how to treat it but unfortunately he is not taught, or at least it is not impressed upon him, that he is dealing with a living organism that responds as a whole and that sundry essential organs may be affected both by the lesion and its associated physiologic dysfunction, and the stress of the surgical procedure. It is of vital importance that such states as dehydration, anemia, disturbances in the acid-base balance, starvation, and the like be corrected if possible before any major surgical procedure is attempted. Coller and his co-workers have contributed an invaluable service in their detailed studies on water balance and if their advice is followed many crises may be averted and much postoperative distress can be prevented.

In the preface to his work, "Fundamentals of the Art of Surgery," Watson stated: "Today many operations seem so simple that the technical skill should be within the grasp of any man who can use his hands with any degree of dexterity at all, and all that is necessary is to learn the steps of the operation and forthwith go and do likewise. This is a false assumption, which has been proved to be so over and over again. The success of an operation depends on much more than this; it entails first a careful and thorough examination of the patient;

[1] INHALATION ANESTHESIA; A FUNDAMENTAL GUIDE. By Arthur E. Guedel, M.D. New York: The Macmillan Co., 1937.

[2] ENDOCRINOLOGY, CLINICAL APPLICATION AND TREATMENT. By August A. Werner, M.D., F.A.C.P. Philadelphia: Lea & Febiger, 1937.

[3] ENDOKRINOLOGIE FUER DEN FRAUENARZT; IN IHRER BEZIEHUNG ZUR OVARIALFUNKTION UND INSBESONDERE ZUR AMENORRHOEE. By Prof. Erwin Kehrer. Stuttgart: Ferdinand Enke Verlag, 1937.

[4] PRE-OPERATIVE AND POSTOPERATIVE TREATMENT. By Robert L. Mason, A.B., F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1937.

second, an adequate pre-operative preparation; third, a careful anesthesia; fourth, the proper organization and equipment of the place for the operation; fifth, a due appreciation of the powers of the patient and his ability to stand the strain to be imposed upon him; sixth, adequate facilities for postoperative treatment; and last, directions for the after-care of the patient. The more one sees of practical surgery the more one is impressed by the relative frequency of unforeseen complications, and when one carefully thinks out the cause of these troubles it is only to find that most of them could be prevented." This was written over 10 years ago yet bears repeating again and forms much of the basis of Mason's work.

The pre-operative study of the patient from the standpoint of the operative risk including heart disease, hypertension, nephritis, diabetes, and the like is discussed. Postoperative shock, acidosis and alkalosis, ileus, acute dilatation of the stomach, dehydration, pulmonary and urinary complications, parotitis, thrombosis, peritonitis, and the like are taken up. It is interesting to note the high percentage of serious lung complications reported from their institution. At the close of Part I there is incorporated a very instructive article on superficial burns. The wisdom of devoting 30 pages to this subject, which is a well recognized surgical entity, in a work on pre-operative and postoperative treatment may be questioned; this especially in view of the fact that only 4 pages are devoted to shock and its management.

In Part II the author discusses the pre-operative and postoperative care of the patient from the viewpoint of regional surgical conditions and operations. This part, like the first, is quite comprehensive and very little which is of significance is omitted. The style of the presentation is good and the text is well illustrated and easily read. One may question the advice as to re-operation in the presence of postoperative hemorrhage after gastric surgery. A blood transfusion obviates this necessity in the majority of cases and eliminates the danger incident to an operation.

The final impression left by this work is that it will find a great field of usefulness in the hands of the interne, resident, and young and inexperienced surgeon. Its conciseness and brevity are added attractions.

JOHN A. WOLFER.

BOOKS RECEIVED

Books received and acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

OPERATIVE OBSTETRICS; A GUIDE TO THE DIFFICULTIES AND COMPLICATIONS OF OBSTETRIC PRACTICE. By J. M. Munro Kerr, LLD., M.D., F.C.O.G. 4th ed. With the Assistance of Donald McIntyre, M.D., F.C.O.G., and D. Fyfe Anderson, M.D. Baltimore: William Wood & Co., 1937.

THE POSTMORTEM EXAMINATION. By Sidney Farber, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

THE 1937 YEAR BOOK OF RADIOLOGY. DIAGNOSIS. Edited by Charles A. Waters, M.D. Associate Editor Whitmer B. Firor, M.D. THERAPEUTICS. Edited by Ira I. Kaplan, B.Sc., M.D. Chicago: The Year Book Publishers, Inc., 1937.

POST-GRADUATE SURGERY. Edited by Rodney Maingot, F.R.C.S. (Eng.). Vol. 3. New York: D. Appleton-Century Co. Inc., 1937.

THE ROENTGENOLOGIST IN COURT. By Samuel Wright Donaldson, A.B., M.D., F.A.C.R. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

THE THINKING BODY; A STUDY OF THE BALANCING FORCES OF DYNAMIC MAN. By Mable Elsworth Todd. Foreword by E. G. Brackett, M.D. New York and London: Paul B. Hoeber, Inc., 1937.

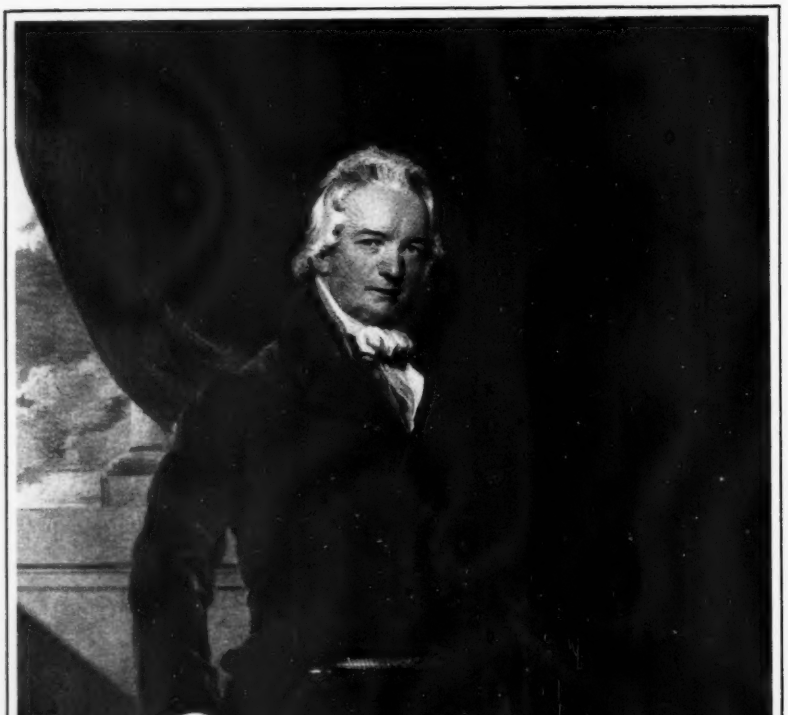
PSEUDOCYESIS. By George Davis Bivin, Ph.D., and M. Pauline Klinger, M.A. Bloomington, Ind.: The Principia Press, Inc., 1937.

OXFORD MEDICAL PUBLICATIONS. THE ABDOMINAL SURGERY OF CHILDREN. By Sir Lancelot Barrington-Ward, K.C.V.O., Ch.M., F.R.C.S. (Edin.), F.R.C.S. (Eng.) 2d ed. London: Oxford University Press, 1937.

THE PHYSIOLOGY OF THE KIDNEY. By Homer W. Smith, A.B., Sc.D., M.S. (Hon.). New York: Oxford University Press, 1937.

OXFORD MEDICAL PUBLICATIONS. THE MANAGEMENT OF THE PNEUMONIAS; FOR PHYSICIANS AND MEDICAL STUDENTS. By Jesse G. M. Bullowa, B.A., M.D. New York: Oxford University Press, 1937.

SYNOPSIS OF GENITOURINARY DISEASES. By Austin I. Dodson, M.D., F.A.C.S. 2d ed. St. Louis: The C. V. Mosby Co., 1937.



Painting by Sir Thomas Lawrence

Original Engraving by William Bromley

John Abernethy

1764-1831